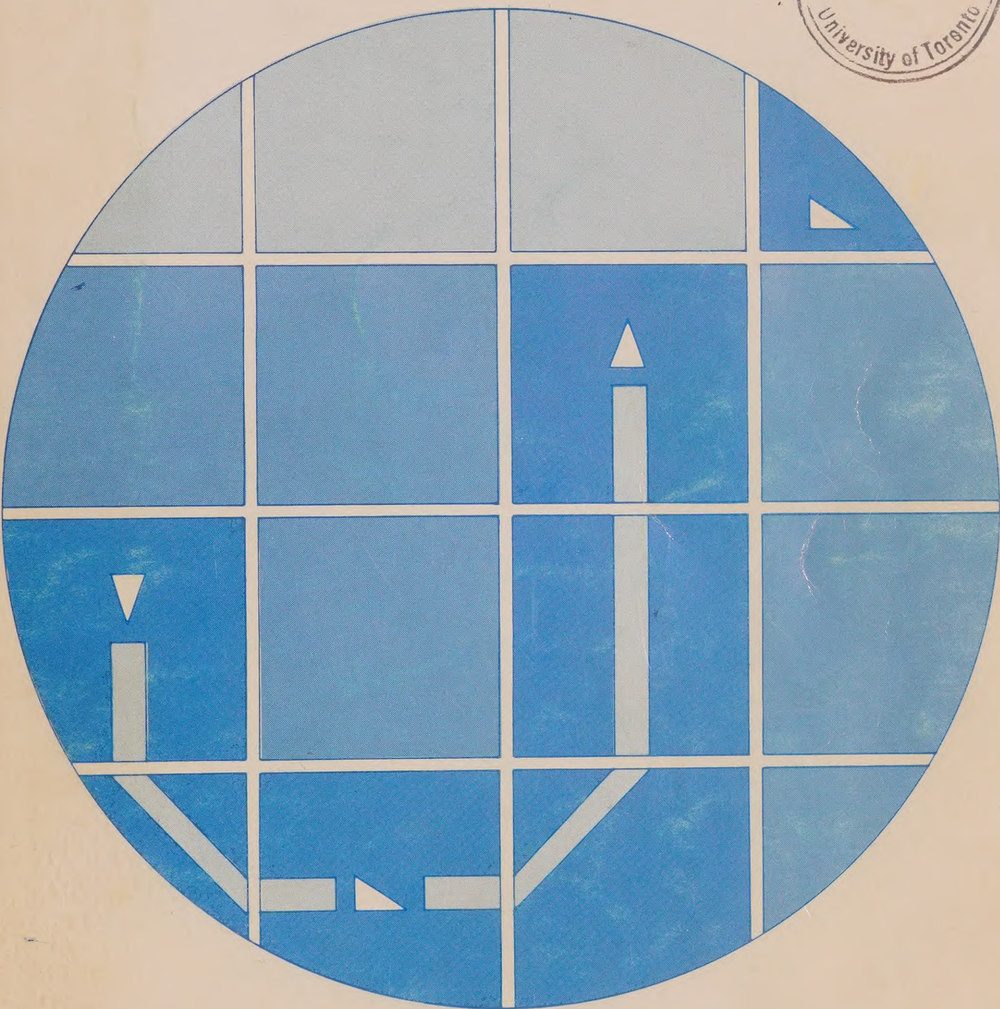
STOL and SHORT HAUL Air Transportation in Canada



Transport Canada — Transports Canada

Air — Air

Copies of this report may be obtained from Public Affairs Branch, Transport Canada, Tower "C", Place de Ville, Ottawa, Ontario, K1A 0N5.

TP 1494

STOL and Short Haul Air Transportation in Canada

July, 1978

Transport Canada Transports Canada

Air Air

Cat. No. T59-2/1978
ISBN 0-662-10060-3

TABLE OF CONTENTS

OTTO LANG
Minister of Transport

The development and application of Short Take Off and Landing (STOL) aircraft technology has been the subject of numerous government and industry studies over the past decade. In particular, proposals have been considered to build compact STOL airports close to urban centres in order to reduce total trip time for journeys between major urban centres of less than 500 miles. This type of STOL air service would also help ease congestion at overcrowded conventional airports.

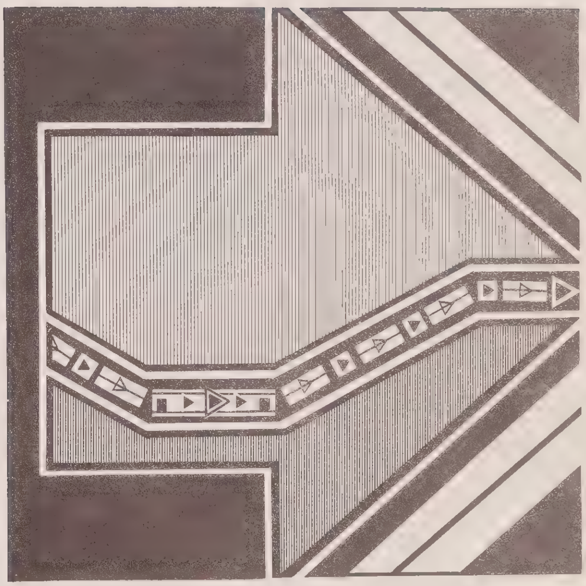
Canada has been a world leader in this field. The federal government has been an active participant in the development of STOL technology, recognizing in it an opportunity not only to advance Canada's aerospace industry, but also to discover and apply innovative solutions to our transportation problems.

A 1970 report by the Science Council of Canada provided the first comprehensive overview of the potential of a Canadian STOL air transport system. Subsequent government involvement in STOL has included financial support for the development of the 50-seat, de Havilland DASH-7 STOL airliner, development and testing of various STOL support systems, planning and implementation of the *Airtransit Demonstration Project,* the acquisition of the de Havilland Aircraft company, and a careful assessment of the potential applications for STOL technology. All these activities are reviewed in the pages that follow.

The federal government has worked closely with all other parties interested in or potentially affected by STOL. These include other levels of government, the aerospace industry, air carriers, citizens' groups in areas close to proposed STOLports, and others.

This report describes the potential for wider application of the STOL concept in Canada, and outlines the factors that should be considered in deciding how this potential can best be realized.

Otto Lang



Section 1

Introduction

SECTION 1

Introduction

PURPOSES OF REPORT

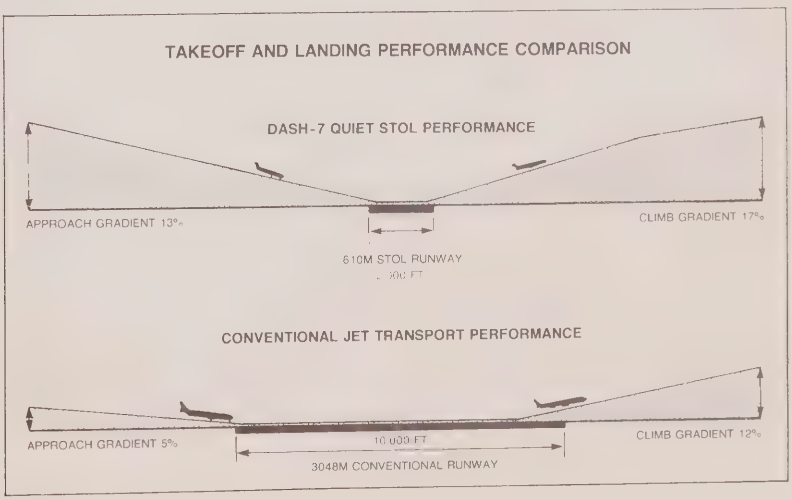
The purposes of this report are threefold: to describe potential roles for Short Take-Off and Landing (STOL) aircraft and support systems in Canada; to indicate the steps that could be taken to encourage their greater use in Canada; and to discuss the factors to be considered in deciding whether such encouragement would be desirable. Special attention is given to the possible establishment of a STOL system in the Quebec-Windsor corridor.

WHAT IS STOL?

The acronym STOL has never had a precise, universally accepted meaning. STOL aircraft are generally understood to be all aircraft capable of operating from runways of a certain prescribed maximum length. Conversely, CTOL (conventional take-off and landing) aircraft are those requiring longer runways. A standard of 2,000 feet was proposed at one time for this "prescribed maximum length", but it was never officially adopted by governments or by the air transportation industry.

Confusion with the term STOL tends to occur when it is used in referring to a complete air transportation system, consisting of STOL aircraft, airports, navigational systems and sometimes even integrated ground transportation. This concept, which in this report will be called *downtown, intercity STOL*, usually involves the following components:

- a network of routes up to 500 miles in length;
- quiet STOL aircraft able to take-off and land at steep angles;
- small urban or suburban airports, called STOLports, having a single STOL runway and simple, efficient passenger processing facilities;
- landing and en route navigational systems that permit safe, all-weather STOL operations; and
- an integrated ground access system between STOLports and city centres.



The main objectives of the *downtown, intercity STOL* concept are to:

- provide a convenient intercity transportation service for routes up to 500 miles in length;
- reduce door-to-door travel times for short-haul air travel, by reducing ground airport access and terminal occupancy times; and
- relieve congestion and delays at conventional airport facilities by diverting a portion of the conventional short-haul air traffic to STOL.

As originally conceived, such STOL systems require at least one STOLport in each city having STOL services. The concept is now seen as also applying to STOL operations between STOLports and conventional airports.

PRESENT USE OF STOL IN CANADA

STOL aircraft are presently used in Canada in two kinds of locations: in providing services to remote and northern areas, and to small communities and regional centres.

Small STOL aircraft such as the nineteen-seat de Havilland Twin Otter have provided the main access to many isolated communities in Canada. These aircraft, capable of landing on water, ice or short unpaved airstrips have been essential in the transportation of passengers and goods to such communities.

Many small communities and most regional centres already have well developed airports capable of handling larger turboprop and in some cases jet aircraft. Although there is no need to serve these communities with aircraft having STOL capabilities, there have been many instances where STOL aircraft have been used effectively in providing conventional air services. Some communities do have more limited airport facilities, however, that are restricted to use by small aircraft or by aircraft with STOL capability.

In all such areas there are potential benefits to be realized when costly runway extensions can be avoided through greater use of STOL aircraft. Further, with the recent certification of the de Havilland DASH-7, a 50 seat, quiet STOL aircraft, a wider range of possible STOL applications can now be considered. These possibilities are discussed later in this report.

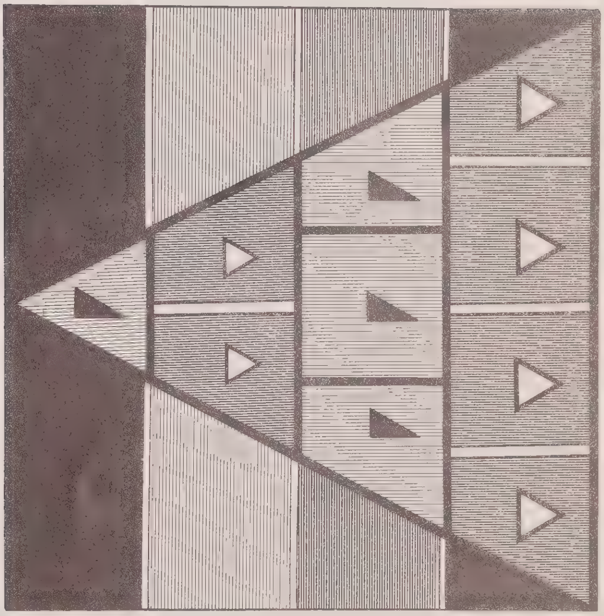
POTENTIAL URBAN STOL APPLICATIONS IN CANADA

The principal focus of this report is on the potential use of STOL aircraft in providing service between urban areas in Canada, with special attention given to the possible establishment of a DASH-7 *downtown, intercity STOL system* in the Quebec-Windsor corridor.

For more than a decade, the merits of the *downtown, intercity STOL* concept have been widely debated, in Canada and abroad. Through the development of the DASH-7, the implementation of the STOL Demonstration Service between Montreal and Ottawa, and numerous technical studies, much has been learned about the STOL system concept generally, and about the advantages and disadvantages of its possible establishment in the Quebec-Windsor corridor. This report is largely devoted to providing a summary of the main findings of these activities.

OUTLINE OF REPORT

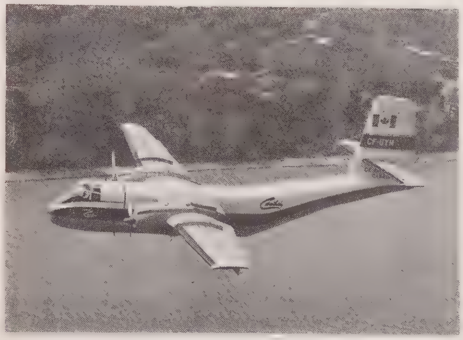
The decision to develop the DASH-7 is reviewed in Section 2 of this report. Section 3 discusses the objectives, operation and findings of the STOL Demonstration Service. Possible applications of STOL aircraft and systems in Canada are described in Section 4. This section also identifies eleven factors to be considered in deciding on the merits of any proposed downtown, intercity STOL system. Section 5 contains an evaluation of specific proposals for a *downtown, intercity STOL system* in the Quebec-Windsor corridor, in the context of the eleven factors identified in Section 4. Section 6 summarizes the main conclusions of Sections 4 and 5.



Section 2

STOL Development in Canada

The Otter



The Caribou

The Buffalo

SECTION 2

STOL Development in Canada

EARLY INTEREST IN STOL

Canada's identification with STOL dates back to the days of the early bush pilots. It was not until the development of the very successful "Norseman" in 1935, however, that an aircraft was designed with performance characteristics particularly designed for Canada's requirements. This approach was adopted by de Havilland in 1946 with the Beaver and later the Otter aircraft. The early Otter was followed by the Caribou, the Buffalo and the highly successful Twin Otter, when it was found that aircraft with short take-off and landing capabilities met a civil and military demand abroad as well as in Canada. With government support, a basis was established for Canadian specialization in a field largely neglected by other aerospace industries.

During the late 1960's, it became apparent that the rapid growth in air transportation was forcing its development in a direction which was becoming less convenient for short-haul travellers. Problems of airport congestion and increasing trip times were making short flights on conventional aircraft less attractive. A number of government and private bodies in Canada saw an opportunity to solve these transportation problems and to develop further Canadian expertise by exploiting the experience gained from the development of the Twin Otter.

SCIENCE COUNCIL REPORTS

This opportunity was also described by the Science Council of Canada in a series of reports recommending that Canada move quickly to become an innovative industrial nation. The Council defined as a *major program* a concerted and cooperative effort on the part of Canadian governmental, industrial and scientific communities to take advantage of an opportunity to solve a serious and complex problem. It identified transportation as a specific area of action and proposed that STOL should be adopted as a major program, as it was one of the few remaining opportunities for Canada in world aerospace markets.

The DASH-7 — then on the drawing boards — was specifically mentioned as the leading STOL transport airplane to establish Canada's position with STOL and to inaugurate the evolutionary growth of the whole system.

In a December 1970 report, the Science Council urged that a major program "be launched soon and vigorously" and that, in addition to the development of the de Havilland DASH-7 and the other STOL system components, a demonstration STOL air transport service be established using de Havilland Twin Otter aircraft. The Science Council's recommendations were well received by the Canadian aerospace industry, which itself had made similar proposals to the federal government. De Havilland and Boeing market research carried out in 1971 indicated a rising world-wide demand for improved short-haul STOL air transport services.

Although the potential benefits of STOL had been evident for several years, there was a deadlock inhibiting its development. Airlines were unwilling to order STOL aircraft without the assurance that STOLports and an appropriate regulatory environment would exist. Manufacturers and the financial community would not invest in a STOL aircraft construction program without the assurance of a viable market for the product. Government authorities would not establish regulations or build STOLports before the major elements of the system had been well defined by the industry. Although the Science Council report clarified many aspects of the problem, it was evident that some government action was needed to break this deadlock.

FUTURE DEMAND IN CANADA

A federal government assessment of the future demand for STOL services in Canada and the aircraft required to meet that demand was carried out at about the same time as the release of the Science Council Report. It noted that while the congestion problems experienced in the United States and in some European cities had affected Canada only to a small degree, the

seeds of those problems were evident in the metropolitan centres of Montreal and Toronto. Noise was a problem, as was access to airports in some centres. It concluded that there would be a demand for STOL services if they could offer a reduction in total travel costs.

This 1970 assessment suggested that STOL services probably could be introduced in Canada in the 1970's and that the following applications might be included:

- Intercity high density routes;
- Intercity low density routes including feeder and air taxi services; and
- Regional and Northern Canada operations where terrain and low demand did not warrant major investments in runway facilities.

High Density Routes

Evidence suggested that the demand would be greatest for high density operations and that the most likely routes would be:

Montreal — Boston
Montreal — New York
Montreal — Toronto
Toronto — New York

Most routes within this class were thought to require a STOLport at each point (possibly more than one in some cases). It was thought that STOL services would reduce but not eliminate parallel conventional services, if only because many of the latter form part of longer-haul operations. Furthermore, some passengers would choose to patronize faster and higher flying conventional aircraft.

STOL's possible market penetration was also studied. Including projected traffic growth, it was estimated at that time that between 30 and 40 DASH-7 aircraft would be necessary to satisfy the demand by 1980.

Low Density Routes

The second application envisaged was for services between a STOLport and a conventional airport. In many locations conventional airports were sufficiently close to the centre of traffic generation that STOL operations could be based there. It was thought that the following routes could develop from downtown STOLports in Toronto, Montreal and Victoria.

Toronto — Windsor
Toronto — Cleveland
Toronto — Ottawa
Montreal — Ottawa
Victoria — Vancouver

Regional and Northern Routes

It was not possible to identify individual routes in the third application. Though it was speculated that STOL systems could lead to savings in runway costs, it was noted that Northern Canada was opening up quickly and most points of significance already had airstrips designed for conventional aircraft. Furthermore, where development of natural resources had preceded construction of highways and railroads, heavy machinery had been moved in by air in large all-cargo aircraft which demanded conventional length runways.

DASH-7 MARKET POTENTIAL

On the basis of market studies by de Havilland and Boeing, it was concluded that the DASH-7 had a high world-wide market potential and that carriers and passengers were ready to use this aircraft as quickly as it became available. The DASH-7 was considered better configured to meet any evident demand than any other aircraft likely to be available in the early part of the decade. In short, it was thought that an opportunity was at hand, and it was simply a matter of recognizing it and taking the reasonable risks inherent in any new development of this kind.

FEDERAL COMMITMENT TO STOL

In May 1971, the federal government announced that it would proceed with a demonstration service between Montreal and Ottawa and would investigate the possibility of establishing a major program for the development of a STOL air transport system. Seventeen months later, the Minister of Industry, Trade and Commerce announced that the federal government would fund 90% of the cost of developing two pre-production DASH-7 aircraft, which would be used for certification and marketing purposes.

In spite of the government's decision to provide nearly all of the development funds for the DASH-7, the project was not fully supported by de Havilland's parent company, Hawker-Siddeley, a British aircraft manufacturer. This caused the federal government to take control of the firm in May 1974.

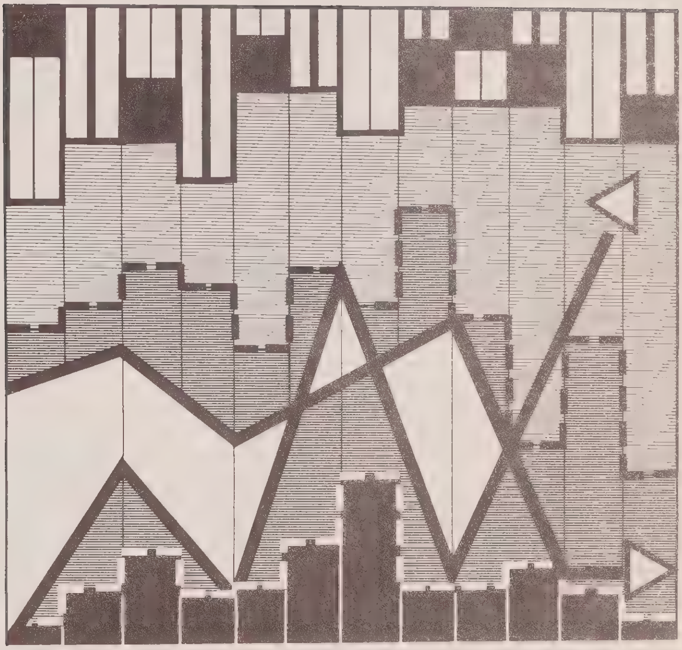
DASH-7 SALES

The DASH-7 received its airworthiness type approval in 1977. Rocky Mountain Airways has taken delivery of the first production aircraft, has purchased a second and has an option for a third. The Department of National Defence has purchased two DASH-7's for use in Europe. Purchase contracts for one DASH-7 each have been signed by Greenlandair (with an option on another), the United Arab Emirates and Spantax, a Spanish charter operator. Wardair has indicated it will purchase two DASH-7's for use in Western and Northern Canada and has options on three more. Several other sales are under active negotiation.

Despite these recent sales and the generally accepted fact that the DASH-7 is a remarkably versatile aircraft, the market response has been slower to develop than was expected. There are many reasons for this situation.

- **COST** – Many carriers feel that the cost of the aircraft, together with the introductory costs of putting a new type of aircraft into service, places too heavy a front-end financial burden on them.
- **LACK OF DOMESTIC OPERATIONS** – The credibility of the DASH-7 program suffers from the fact that, as yet, this aircraft is not being used in Canada. Foreign carriers have expressed concern over the lack of Canadian sales and have requested assurances of a viable production run.
- **LACK OF A COMMERCIAL DEMONSTRATION** – Convincing proof of the passenger appeal and favourable economics of the DASH-7 can only be demonstrated through actual commercial operations.

Despite the confidence expressed by de Havilland and Boeing, the number of aircraft sales to date has been disappointing. It is clear that the DASH-7 needs a "launch market" and some government action may be necessary to help overcome the problems outlined above.



Section 3

The Airtransit Demonstration Project

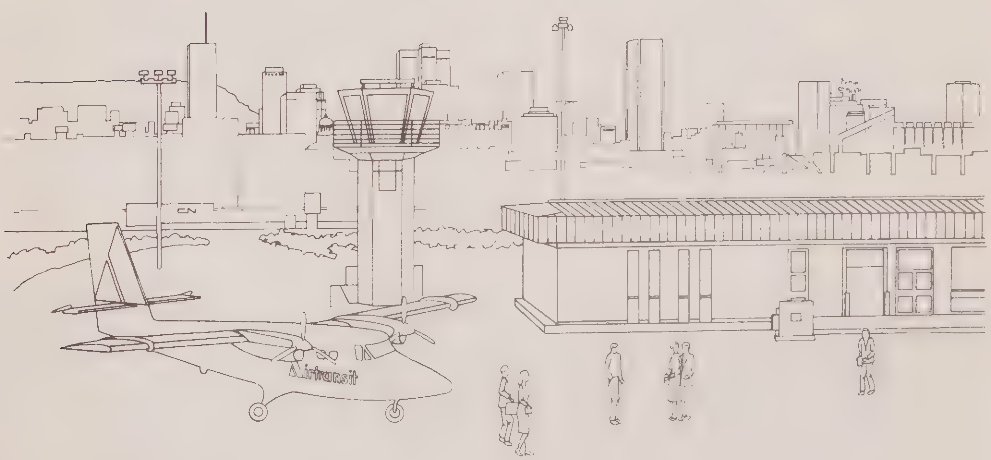
SECTION 3
The Airtransit Demonstration Project

INTRODUCTION

The federal government's decision to proceed with a STOL Demonstration Service was intended to demonstrate the potential merits of the STOL air transport system concept. The Demonstration was to be the focal point for the development of downtown, intercity STOL transport systems by providing:

- valuable technical data on STOL system operations in a busy air transportation environment;
- experience necessary for the development of air safety regulations for future STOL services;
- cost and revenue information that could be applied to other STOL services;
- data on community reactions to urban and suburban STOLports;
- ideas on the travel markets to which a STOL system would appeal; and
- information helpful to the industry in deciding how best to market its products.

Activities commenced with studies carried out in 1971 and 1972 to provide the basis for selecting components of the Demonstration Project: aircraft, avionics, routes, sites, and STOLport facilities.



Several STOL route possibilities in Canada were studied. The Montreal-Ottawa route was selected because it offered high visibility to foreign visitors; there was strong modal competition on the route; and it was a good route length for the Twin Otter, the only commercial STOL aircraft immediately available. The STOLport sites were chosen to provide examples of city-centre and suburban locations in Montreal and Ottawa respectively.

PROJECT IMPLEMENTATION

Airtransit Canada

Airtransit Canada, a wholly-owned subsidiary of Air Canada, was formed solely for the purpose of operating the STOL Demonstration Service.

All necessary funds for the organization and operation of Airtransit, net of any revenues received by Airtransit, were provided by Transport Canada under a contractual agreement. Airtransit also was provided with:

- six aircraft under lease with supporting spare parts inventory;
- terminal and hangar space and ramp facilities;
- enroute navigation, landing aids and meteorological services.

The company was required to pay landing fees, rents for terminal and hangar space and all other charges normally applied to carriers at a Transport Canada airport.

The assembling of personnel and pre-operational training began in the late fall of 1973. Commercial operations commenced July 24, 1974 and terminated April 30, 1976.

Aircraft

The Twin Otter aircraft used were modified to conform to transport category airworthiness performance criteria. Cabin changes were also made to bring the overall comfort level closer to that of the DASH-7 interior and thus provide a better simulation of future STOL services. The aircraft were outfitted with eleven DASH-7 seats. Certain DASH-7 features, notably its greater headroom and lower noise levels, could not be simulated.

STOLports

A complete STOLport, comprising terminal, hangar, maintenance garage and control tower, was designed by the Canadian Air Transportation Administration. These structures, along with the runway and several associated landing aids, were installed at the STOLport sites.

The STOLport facilities and STOL service were designed for:

- a potential annual two-way passenger traffic volume of 150,000;
- at least 300 operational days per year;
- an average of 200 passengers per day each way;
- an all-weather operation;
- a fleet of six Twin Otters with a seating capacity of 11 passengers, operating at a 60%-70% load factor;
- 22 flights daily each way over a 16-hour period per day.

The Victoria STOLport in Montreal was built on the site of a former garbage dump that previously had been levelled for use as a parking lot. Because of space limitations, the terminal was

located at one end of the runway, which was used for taxiing as well as take-off and landing. This caused some interference between arriving and departing aircraft when short flight intervals were scheduled.

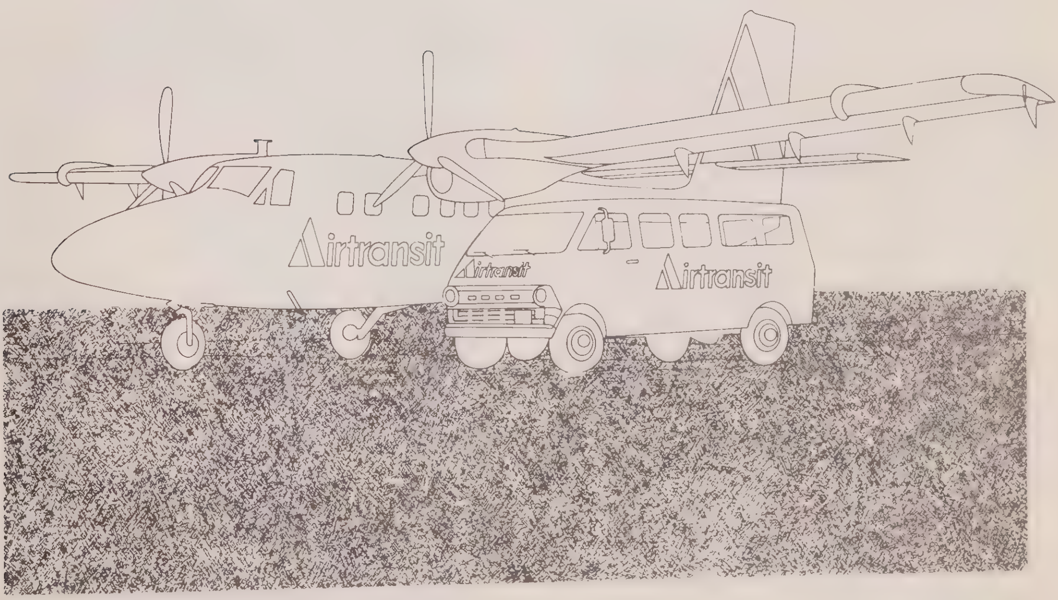
The Ottawa STOLport was constructed on the site of Rockcliffe airport, which continued to be used for general aviation. The centrally located terminal proved adequate throughout the entire Demonstration.

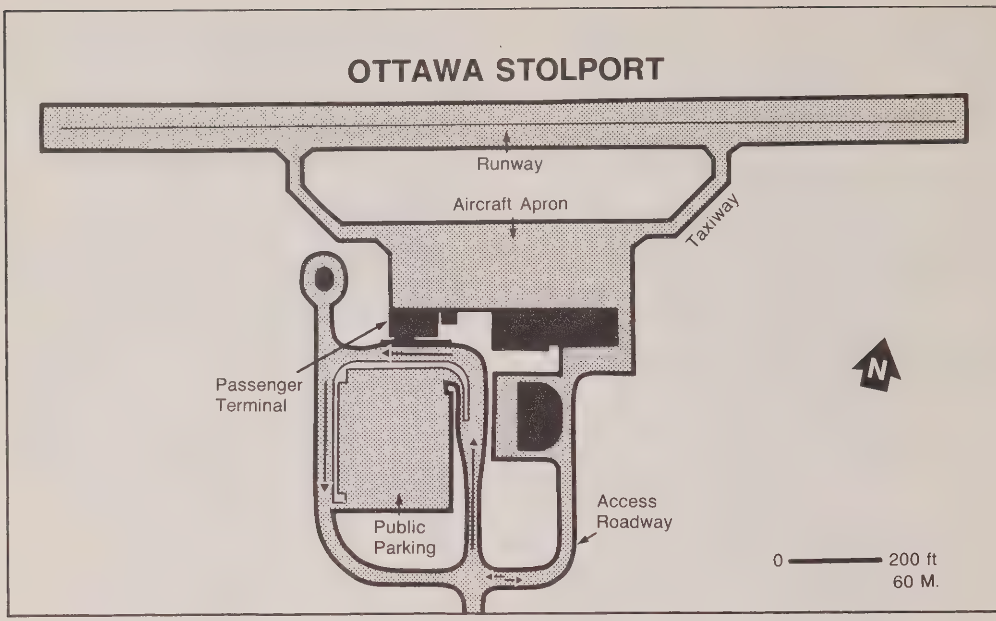
Microwave Landing System

A microwave landing system (MLS) was utilized to provide a precision instrument approach capability. A steep approach angle (6 degrees) was adopted in order to clear obstacles and reduce noise levels, both of which are important to a city-centre STOL concept.

Area Navigation

An area navigation system was used for enroute navigation. Fixed, dedicated, three dimensional flightpaths were provided from take-off to touch-down. The navigational data was stored in an on-board computer. With the increased accuracy and flexibility of this system, a more efficient use of the air space in a high density air traffic area was achieved.



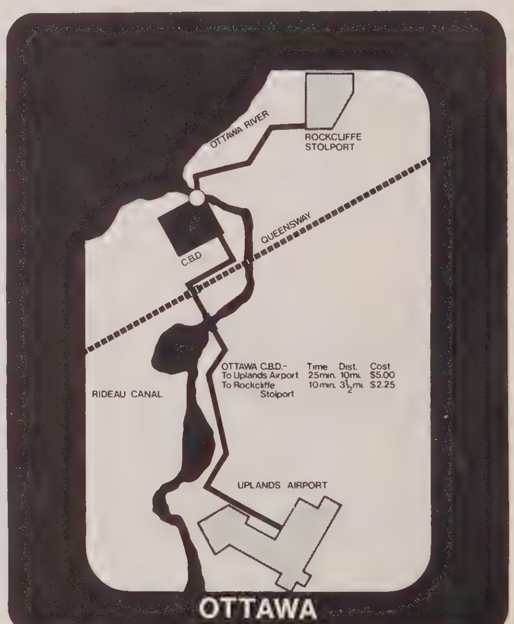


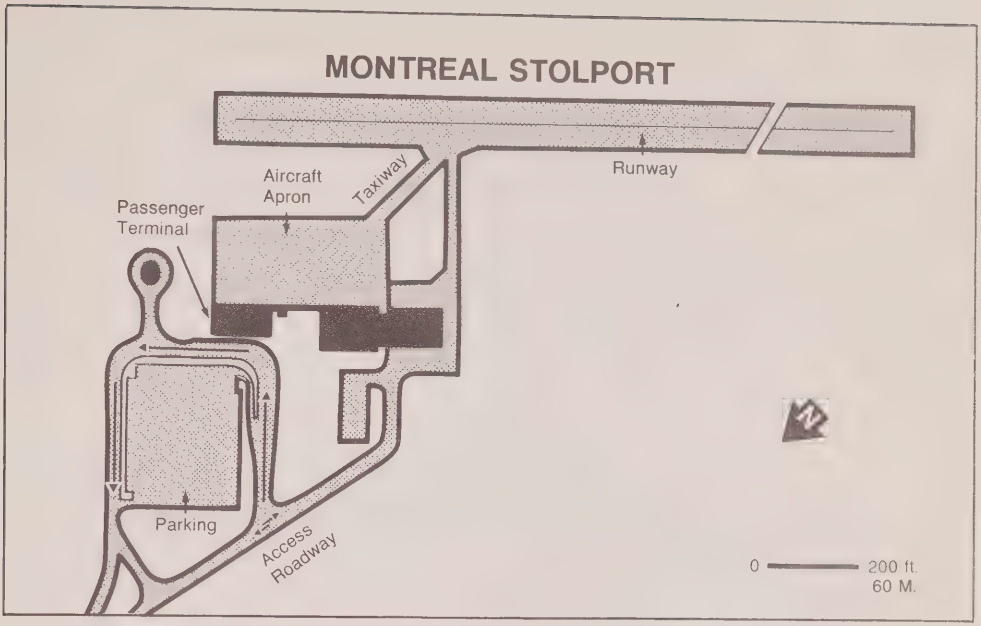
AIRTRANSIT OPERATIONS

Integrated Ground Transport

Airtransit provided a complete downtown-to-downtown service consisting of the air link between the Victoria and Rockcliffe STOLports and a dedicated mini-bus (STOLmobile) service to the respective central business districts (CBD's) at each end. The Montreal CBD, about 4 square miles in area, was 2 miles from the Victoria STOLport. STOLmobiles left the downtown terminus 15 minutes before flight departure. The Ottawa CBD, about 2 square miles in area, was 6 miles from the Rockcliffe STOLport. STOLmobiles left the downtown terminus 30 minutes before flight departure because of the greater ground distance in Ottawa. In each city over 50% of the passengers came from or were destined to the CBD.

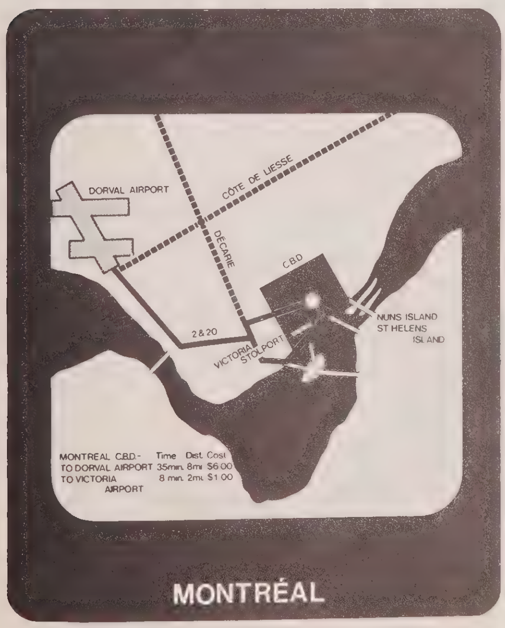
Two-thirds of all passengers used the STOLmobile service. The STOLmobiles were identical in each city and had a seating capacity matching that of the aircraft. The service was free and, once on board the STOLmobile, a passenger was assured of making his flight.





Passenger Processing

The procedures at the STOLport, inspired by the speed and simplicity of ticketing on urban transit systems, further reduced the trip time.



The passenger handling procedures allowed customers to be processed quickly. A simple manual form of reservation system was developed and was quite appropriate for the single link Airtransit service.

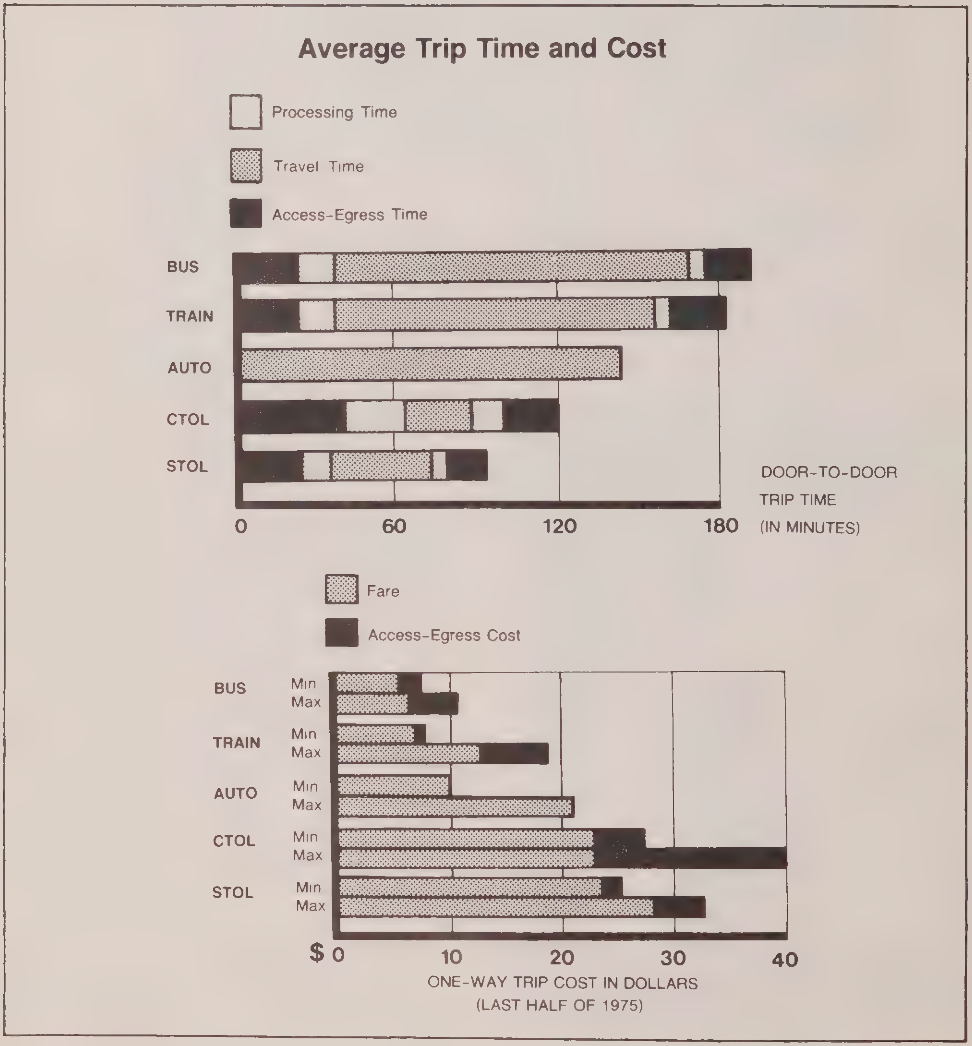
The ticket counters and passenger areas proved adequate for flight intervals down to 15 minutes. The average check-in time was less than 2 minutes per passenger and the entire boarding process for a plane load from the beginning of security check to "door shut" required 5 to 6 minutes. The deplaning process for a full load from "door open" until the last passenger entered the terminal was less than 1 minute.

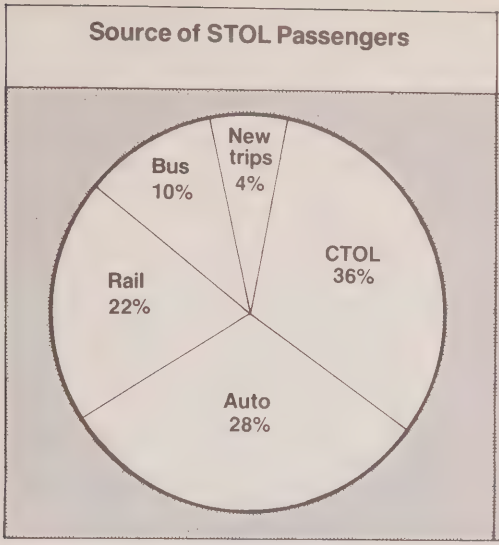
Trip Time

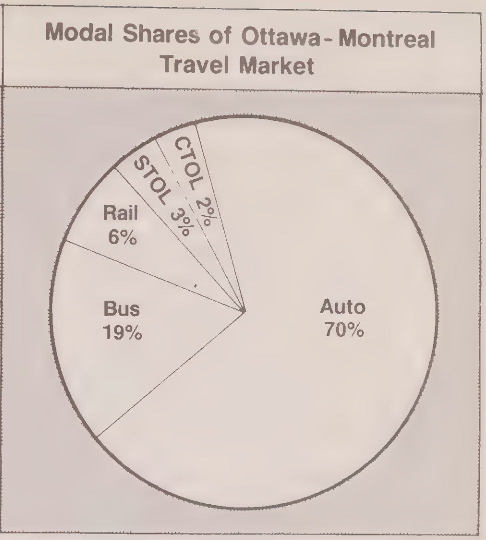
Total trip time was very short, averaging about 80 minutes downtown-to-downtown. Air time was about 45 minutes; the STOLmobiles arrived at the terminal 10 minutes prior to flight time and left the terminal within 5 minutes of aircraft touchdown. The total time spent in the two STOLmobiles was about 20 minutes.

Departure Frequency

An important feature of the Airtransit service was the high frequency of departures on weekdays. Throughout most of the day the flights were on the hour and the half hour to provide a simple, easily-remembered schedule. At peak hours a third flight was often added to provide increased capacity. At the height of the service, 62 daily STOL movements were scheduled for each STOLport.







PASSENGER ACCEPTANCE

Market Response

Passenger acceptance was a critical aspect of the Demonstration. There were very strong doubts that small, propeller driven, unpressurized aircraft flying at low altitudes and operating in and out of small STOLports at unusually steep flight-path angles would find any lasting acceptance by the target market of business travellers. These doubts were soon dispelled.

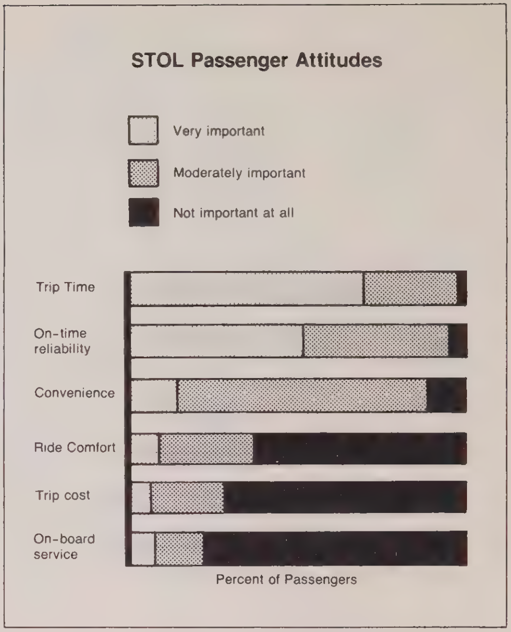
The Demonstration captured a share of the Montreal-Ottawa travel market despite strong competition from the regular CTOL service, a particularly convenient bus service and a road trip time that made bus and automobile times highly competitive with air travel. Market forecasts correctly indicated that STOL would capture 100,000 passenger trips per year (3% of the total passenger market). But the speed with which traffic did build up surprised even the optimists. Once started, the appeal of the service was evident. The peak period capacity was soon reached, a relatively stable weekday traffic pattern developed and the market was fully developed at the forecast level within six weeks of the first revenue flight.

During the 21 months of the Demonstration, 157,700 passengers were carried with an average load factor of 59.8% being achieved on the 23,895 revenue flights made. In the peak morning period, the number of requests for seats on certain flights was regularly more than twice the capacity. Traffic was mainly business-oriented (98%). Demand on weekends was almost non-existent.

Airtransit travellers were drawn from all of the four existing modes: automobile, bus, train and conventional air service. The two endpoints of the route, Montreal and Ottawa/Hull, generated a total of 2.87 million one-way trips between them in 1975. The STOL service captured 3.3% of this market. The greatest impact was felt by conventional air service (CTOL), which lost 37% of its local traffic and accounted for 36% of the STOL passengers. Rail and bus respectively lost 11% and 2% of their local passengers to STOL.

Passenger Appeal

The STOL Demonstration Service found immediate and enthusiastic favour with a large segment of the business market. These users, who were largely price insensitive, found the service fast, simple and exceptionally convenient. Much of the success of Airtransit was related to the short travel time and the convenience the service offered. Airtransit provided short access and egress times, frequent departures, rapid passenger processing, STOLmobile terminal points at convenient downtown locations and prompt departures. Frequency of flights gave travellers the option of leaving at any hour of the day and 56% of respondents stated that this was one of the reasons for selecting Airtransit. The service enabled people to achieve either two half days of business, one in each city, or a full day's business in the destination city without having an excessively extended workday.



COMMUNITY REACTION

The STOL operational system was conceived as an air service that would not have undesirable effects on communities near its terminals. The small airport acreage required, the low exhaust emissions, the low noise and the steep flight path characteristics of STOL aircraft were all oriented to minimizing the community impact.

Noise and Air Pollution

The Montreal site was well isolated from residential communities and residential areas under the flight path experienced relatively high ambient (i.e. normal background) noise and air pollution levels. In contrast, the suburban residential area in Ottawa near the STOLport site enjoyed much lower levels. In both locations, the introduction of the STOL service was correctly predicted to have no measurable effect.

Throughout its operational life, the Demonstration Service elicited no complaints from the public on the grounds of noise or air pollution.

Opinion Surveys

As a means of determining public opinion, a series of interviews were conducted among people residing close to the STOLports and the approach and departure flight paths. Three surveys were undertaken; one before the commencement of the commercial service, one while the service was operating and one following the termination of the service.

The majority of responses to all surveys were favourable. Before the Demonstration, there was some opposition among Ottawa residents related to noise, air pollution and increased traffic. There was little opposition in Montreal.

By the second survey, much of the opposition and the 'wait and see' form of resistance in Ottawa had evaporated because the minimal impact of STOL aircraft in operation had been satisfactorily demonstrated.

Following termination of the service, a more detailed set of questions was asked regarding attitudes toward STOL:

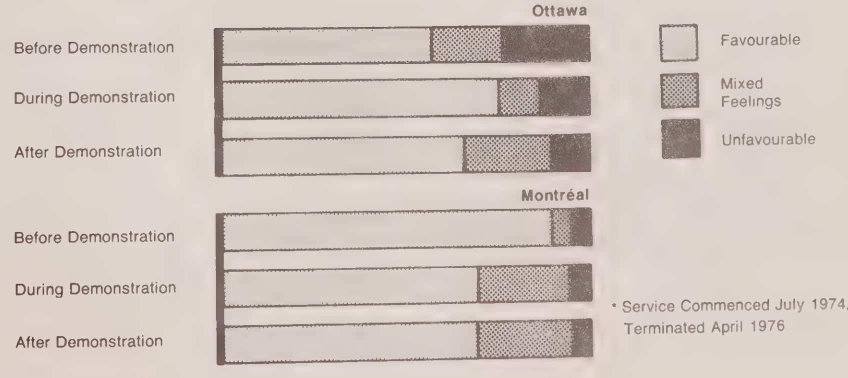
- Would the STOL service be a valuable addition to the transportation system;
- Is it advisable for government to invest in the development of such a system; and
- Should the service between Montreal and Ottawa resume, using either the DASH-7 or the Twin Otter.

Noise and pollution were not mentioned in any of the unfavourable responses registered. The prevailing concern was the economics of the program.

The Ottawa opponents of STOL used economic arguments to support their position, asserting that improved rail service would be a more appropriate intercity transportation development. In Montreal, a similar feeling was expressed as a desire to see more investment in mass transit systems. Those with mixed feelings recognized the value of a STOL system, but felt it should be offered by private industry at a price that would have the users carry the full costs.

Of those interviewed in the final survey, 73% saw the concept as useful even if they would not have occasion to use it. On the question of government development of STOL, 63% of the respondents were favourable on the same grounds. More than half (53%) favoured resumption of the service in its original form. Over 61% favoured use of the DASH-7.

Attitudes Toward Demonstration



FINANCIAL ASPECTS

Project Costs

STOL Demonstration funding was set at $25 million, of which $15 million was earmarked for capital acquisitions and start-up expenses. Operating expenses, both for the airline and for the facilities provided by the government, were expected to exceed revenues as a consequence of planning for a complete system to be fully operational from the first day. The small size of the DHC-6 aircraft used in the Demonstration was also a contributing factor.

The STOL Demonstration Project incurred capital expenditures of $15.2 million. In measuring the capital cost of the Demonstration, a substantial reduction in total capital cost is possible on the basis of the market values of assets absorbed in government departments following the termination of the project. The table below shows the capital expenditures, estimated cost recovery and gross operating expenses and revenues. Taking these factors into account, the true net cost of the STOL Demonstration Project was $14.5 million.

STOLport Capital Costs

The capital costs of the STOL system infrastructure assembled in 1974 for the Demonstration totalled $5.75 million: $2.0 million for the Ottawa site and $3.75 million in Montreal. The higher cost at Montreal was entirely related to the nature of the site, formerly a garbage dump, which required more than $1 million to be expended on fill and grading and which also caused major cost penalties in the construction of the terminal.

The operation and maintenance costs incurred during the Demonstration by the STOLport operátions and the air navigation services amounted to about $1.25 million.

Airtransit Costs and Revenues

In the 21 months of the STOL Demonstration Service, Airtransit operating expenses exceeded revenues, as expected. Total operating costs for the airline amounted to $7.5 million, creating a $4 million deficit. In addition, $1.7 million of start-up and termination costs were incurred by the carrier. The experimental nature of the service was the main reason for the shortfall between costs and revenues.

Severe cost penalties were imposed by the experimental and temporary nature of the STOL Demonstration.

STOL DEMONSTRATION PROJECT COSTS
(millions of dollars)

CAPITAL	
Technical Trials and Studies	2.0
Montreal STOLport Facilities	3.7
Ottawa STOLport Facilities	2.0
Aircraft and Avionics	7.6
Sub-Total	15.3
Less Value of Assets at Termination	(9.9)
NET CAPITAL COST	5.4
OPERATING	
Airtransit Operating Deficit	5.7
STOLports	3.7
Public Affairs	0.6
Data Collection, etc.	0.4
Sub-Total	10.4
Less Transport canada Revenues	(1.3)
NET OPERATING COST	9.1
NET TOTAL COST	14.5

Furthermore, because each aircraft had only 11 passenger seats, a large number of flight crews were required to ensure sufficient space was available for the predicted market.

It was estimated that had Airtransit been operated strictly as a commercial carrier, total annual direct and indirect operating costs could have been reduced by $500,000 and $900,000 respectively, during the calendar year 1975. This would have reduced total operating costs for 1975 by one-third.

As part of the Demonstration activity, the sensitivity of travel demand to the fare level was sought through a series of price changes. Many difficulties hampered this experiment. Even the selection of the initial fare level was a source of contention, which centered around whether it should be greater than, equal to, or less than the existing regular Air Canada fare. The compromise reached was to start at $20.00, the Air Canada fare plus $2.00 (roughly the cost of a single STOLmobile ride).

The two major fare increases made during the Demonstration had no apparent effect on Airtransit traffic.

Trip cost was found to be one of the least important considerations to the Airtransit traveller. It was consistently ranked below such features as travel time, convenience, reliability and even comfort.

STOLPORT COSTS
(thousands of dollars)

	Montreal	Ottawa
CAPITAL COST		
Vehicles	220	220
Tower and Nav. Aids	250	250
Buildings	970	700
Utilities	370	320
Landscape	130	130
Site Preparation	1,800	380
Land Cost	–	–
TOTAL CAPITAL COST	3,740	2,000
ANNUAL OPERATING COST (1975/76)		
STOLport Personnel	250	230
Site Protection	70	10
Land Rent	130	–
Goods and Service	120	80
Air Nav. Services	170	190
Overhead	45	30
TOTAL ANNUAL OPERATING COST	785	540

AIRTRANSIT ANNUAL OPERATING COSTS
(for 1975, in million of dollars)

DIRECT COSTS	
Flight Operations & Maintenance	2.1
Aircraft Depreciation & Lease	0.4
TOTAL DIRECT COSTS	2.5
INDIRECT COSTS	
Passenger Services	0.1
Aircraft & Traffic Servicing	0.6
Promotion and Sales	0.5
General and Administration	0.4
TOTAL INDIRECT COSTS	1.6
STOLMOBILE SERVICE	0.3
TOTAL OPERATING COSTS	4.4

STOL System Commercial Viability

The potential for recovering the costs of constructing and operating STOLport facilities is largely dependent upon the relationship between STOLport costs and passenger volumes. Although STOLport costs would be to some extent site-dependent, total costs per passenger processed would generally be much less for STOLports than for conventional airports. This is mainly because, for comparable traffic volumes, STOLports require far less terminal space and equipment, aircraft gate area, runway length and total site area than do conventional airports.

The Demonstration STOLports were designed to handle up to three Twin Otter departures and arrivals per peak hour, or approximately 150,000 passengers per year (arrivals plus departures). On the basis of experience gained during the Demonstration it was found that these facilities could have accommodated two or three times the volume of traffic for which they were designed. This was mainly because the STOL traveller spent very little time in the terminal building and had very few meeters and well-wishers. The short terminal occupancy times could have been reduced even further had some of the passenger processing been done on board the STOLmobile.

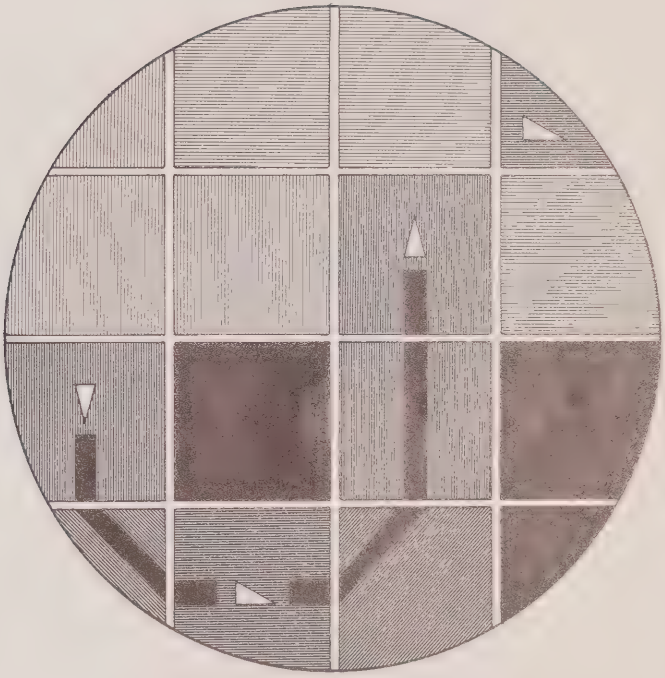
It was estimated that a terminal building the size of those used in this Demonstration, but designed for DASH-7 operations, could accommodate up to 500,000 passengers per year.

CONCLUSIONS

The overall conclusion arising from the Demonstration Project is that the market appeal of any short-haul STOL intercity service will depend on the degree to which it can provide its passengers with a convenient and rapid journey. The most important features of the STOL Demonstration which should be retained in any future intercity STOL service were found to be:

- an integrated ground transportation service providing a rapid link between the STOLport and traffic generating centres;
- a terminal designed to stream passengers rapidly between the airplane and the ground transportation vehicle;
- frequent service to provide a choice of departure times and short waiting periods;
- simple reservations and ticketing procedures;
- direct communications between the ground transportation and the reservation/ticketing services.

A DASH-7 STOL system could operate profitably on short-haul routes, providing a frequent, convenient service from inexpensive, well-located terminals.



Section 4

The Future of STOL Short~Haul Air Transportation in Canada

SECTION 4

The Future of STOL Short-Haul Air Transportation in Canada

There are three main areas where the use of STOL aircraft could, in the future, play an important role in the provision of short-haul air transportation in Canada. These are discussed below.

REMOTE AREA STOL APPLICATIONS

The first area is in the continued use of STOL aircraft for transporting passengers and cargo in and out of airports having short runways. These applications will be found particularly in Northern Canada and in isolated or mountainous areas.

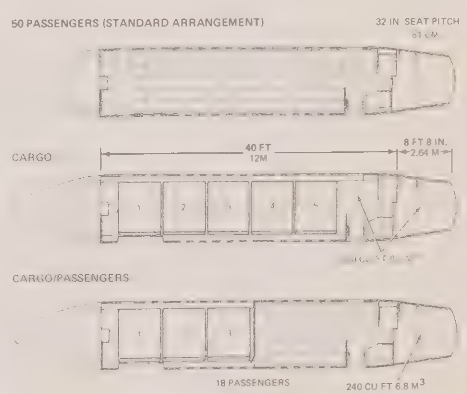
Northern Transportation Programs

The federal government spends substantial sums each year to assist and improve access to Canada's northern communities. In 1976/77, for instance, over $94 million was budgeted for this purpose under various federal programs, including the *Water Transport Program*, the *Northern Air Facilities Program*, the *Transport Canada/DREE Western Northlands Highway Construction Program*, and *Transport Canada's Airports Financial Assistance Program*. Despite these efforts, many northern communities continue to suffer transportation that is seasonally interrupted and irregular.

Under the 1974 *Northern Air Facilities Program*, the federal government has undertaken to provide all communities in the Northwest Territories and the Yukon that have a permanent population of 100 or more with one of three standards of airport facilities, depending on the community's population, its role in economic development and governmental administration, its growth prospects and the frequency and type of air service likely to be provided. It is estimated that the total costs of this program will be in the order of $100 million (in 1978 dollars) and that it will require eight to nine years before all of the infrastructure is in place.

The majority of remote locations in the Arctic and in the northern areas of the provinces have a high potential for the use of STOL technology. Airstrips are often rudimentary, located in difficult terrain and have runways too short for use by larger, conventional aircraft. Airport construction costs are high, ranging from one to two million dollars for a simple airport facility with a 3,000 foot runway. These locations are widely scattered and the level of traffic is low.

DASH-7 CONFIGURATIONS



Potential DASH-7 Uses

The most commonly used aircraft is the Twin Otter, although a variety of other types are also employed. The DASH-7 is particularly suited for use in the North. In addition to its possible use in transporting passengers and cargo between communities having well-developed airports, capable of handling a range of conventional turboprop and jet aircraft, the DASH-7 can also be used for charter services to small northern communities having short, unpaved runways or ice strips.

Potential use of the DASH-7 on a system-wide basis in the remote areas of the provinces and the territories has been examined recently by Transport Canada. Experience gained in implementing the *Northern Air Facilities Program* provided a practical basis for developing a joint government-industry, air services planning approach to ensure the effective use of scarce financial resources. This approach, the Joint Air Service Planning and Evaluation Review (JASPER), is a systematic method of analysis that links the two main cost components of commercial air services:

- aircraft acquisition and fleet assignment; and
- airport planning and construction.

Using this technique, a 1976 Transport Canada study evaluated aircraft/airport alternatives for improving air services to thirty-nine smaller Arctic communities with a total population of 15,550. Based on the same criteria as established in the *Northern Air Facilities Program*, all communities involved had a minimum population of 100. Examination of demand beyond 1978, based upon data provided by carriers, suggested that a number of communities could, by the mid-1980s, support services by medium-sized turboprop aircraft such as the F-27, HS-748 or DASH-7. Trade-offs between aircraft operating costs and airport improvement costs were estimated for the DASH-7 (or increased frequency service using the Twin Otter), the F-27 and the HS-748. The DASH-7, with its requirement for shorter runways than are required for CTOL aircraft, proved a cost-effective solution for certain Arctic air services in the sense that use of the DASH-7 minimized the total of aircraft operating costs and runway construction costs.

While this analysis indicates a potential for cost-effective application of DASH-7 technology in the Arctic, a CTOL option could be favoured by some carriers because of the availability of inexpensive second-hand aircraft, familiarity with this equipment, and because longer runways allow for the use of a wider range of aircraft.

The DASH-7 could prove particularly effective in a mixed passenger/cargo configuration operating to unimproved airstrips with minimal ground support equipment. It could in time replace aircraft such as the venerable DC-3, specialty airfreighters such as the Bristol 170 and the DASH-7's own predecessor, the de Havilland Twin Otter.

An analysis of remote area air traffic growth suggests that before the mid-1980's there is limited potential for the DASH-7 to replace the Twin Otter. The main factor leading to this conclusion is the reduced pace of exploration programs for northern resource development. The explosive growth of freight and passenger traffic in the early seventies has now lessened. Together with a reduced level of growth in the Canadian air carrier industry, this has

made the small carriers who operate these remote air services reluctant to embark upon costly equipment replacement programs.

Improving the potential market for the DASH-7 STOL aircraft in the North would require improvements in carrier growth potential and return on capital investment. It would also require encouragement for carriers now operating the Twin Otter to move up to the larger DASH-7. There is a risk, however, in moving from an eighteen-seat aircraft to a fifty-seat aircraft on low density routes. One answer would be to amalgamate Twin Otter routes into larger networks using the DASH-7. A realignment of some routes is occurring already and this will affect the number of DASH-7 aircraft that could be operated in the North.

DASH-7 Market Potential

Analysis of present and future route structures in the Arctic shows a potential market for as many as six DASH-7 aircraft. Extensive use of the DASH-7 in the Arctic over certain air routes would bring with it substantial savings in airport runway construction.

STOL SERVICES TO SMALL COMMUNITIES AND REGIONAL CENTRES

Another area where STOL aircraft have been used extensively is in the provision of conventional air service to small communities and regional centres in Canada and elsewhere. The Twin Otter for example has for many years been the backbone of many North American local and commuter air carriers' fleets. Even when STOL operating characteristics have not been required, STOL aircraft often have been preferred over other aircraft. The Twin Otter is known as much for its reliability and durability as for its STOL operating characteristics.

Conventional Use of the DASH-7

The DASH-7 in many cases will also be used in applications where its short take-off and landing capability will not be required. Compared to other turboprops of the same size, its modern design offers superior comfort and passenger appeal and greater operational flexibility. It is extremely quiet, inside and out, pressurized, very smooth-flying and attractive in appearance. It can be used for transporting passengers or cargo, or a combination of both.

There are three types of short-haul routes in Southern Canada where the DASH-7 could be used even though its STOL capabilities would not be required:

- Short-haul routes now served by jets where load factors and/or frequency of service are low;
- Short-haul routes now served by turboprop aircraft similar to the DASH-7 in size and speed; and
- Short-haul routes now served by aircraft smaller than the DASH-7 where traffic growth will soon create a need for larger aircraft.

The prospects for introducing DASH-7's on short-haul routes now served by small jets (such as the DC-9, Boeing 737 and BAC-111) depend very much on the routes that it would serve. The DASH-7 has certain advantages over small jets. It can be more economical to operate on short-haul routes having low passenger volumes and, because of its low noise, the DASH-7 may be more acceptable to communities having airports located in noise sensitive areas.

On the other hand, small jets have some advantages over the DASH-7. They can also be used for medium and long-haul services to the North and for Southern charter services. The slower and smaller DASH-7 is not as well-suited for medium and long-haul routes.

The main obstacle to greater use of the DASH-7 on routes now served by turboprop aircraft of similar size and speed is the relatively high capital cost of the DASH-7, in comparison to the cost of secondhand aircraft, and the training and other start-up costs which are always associated with the introduction of a new aircraft type into a carrier's fleet. Canadian airlines operate the following numbers of turboprop aircraft of the same size as the DASH-7.

Type	Owned	Leased	Total
HS-748	3	2	5
F-27	11	3	14
CV-440/580-640	7	1	8
YS-11	2	0	2
Total	23	6	29

The designs of most of these aircraft are 20-25 years old, and some of the airframes have been in service for nearly that long. Although other aircraft are becoming more costly to operate because of poor fuel economy and increasing maintenance needs, there is a brisk trade in secondhand aircraft and their prices, though increasing, are very low compared to the cost of a new DASH-7.

There are some short-haul routes now served with aircraft smaller than the DASH-7 where traffic growth will soon create a need for larger aircraft, or where use of a larger aircraft could reduce operating costs (albeit with reduced frequency of service). Most of these routes are now served with aircraft of Twin Otter size (approximately 20 passengers).

Potential Facilities Cost Savings

As noted earlier, there are areas in Northern Canada where the DASH-7 was found to be cost-effective when compared to other aircraft of similar size, in the sense that use of the DASH-7 minimized the sum of aircraft operating and runway construction costs. Use of the DASH-7 in Southern Canada could also result in some infrastructure cost savings, though probably not to the extent that it could in the North.

Airport Development Programs

The federal government supports the development and operation of airports in small communities and regional centres through two programs. The *Air Transport Program* provides capital and operating funds for all Transport Canada airports, many of which are small and located in cities with populations of less than 50,000. Capital and operating funds are also provided for the development and operation of airports operated by municipalities and other public bodies through the *Airports Financial Assistance Program.*

Under these programs, priorities must be established among competing proposals for the use of capital funds. In assessing the relative merits of proposed airport improvements, cost-benefit analyses are frequently carried out. These analyses seek to determine whether the benefits associated with the proposed capital improvements are

sufficiently large in relation to the costs to justify federal funding of the project.

Proposed Runway Extensions

In the case of proposed runway extensions, the "critical aircraft" has generally been assumed as given. The critical aircraft is the one whose size, weight and operating characteristics determine the minimal requirements for the runway (length, width and thickness).

Proposals for runway extensions generally result from the desire of a carrier to "upgrade" services to a community by switching to a larger and sometimes newer aircraft. These proposals are often supported by the communities affected, even though they frequently result in a reduction in the frequency of air services.

The more costly runway extensions usually stem from the proposed replacement of 10-30 seat piston and turboprop aircraft, requiring 2,000-3,000 foot runways, with 30-60 seat turboprops requiring 4,000-5,000 foot runways, or the replacement of 30-60 seat turboprops with 80-100 seat jet aircraft, requiring 5,000-6,000 foot runways.

Potential Capital Cost Savings

For proposals to lengthen runways from 2,000-3,000 feet in order to accommodate 40-60 seat turboprops, consideration will henceforth be given by Transport Canada to the use of the 50-seat DASH-7 on existing runways as an alternative to runway extensions. In these cases, detailed cost-benefit studies will be carried out.

It may be appropriate to consider also the possible use of the DASH-7 in cases where there is interest in improving airport facilities to allow a carrier to use modern jet aircraft instead of older turboprops, which are often unpressurized and noisy.

One such case concerns the airports in the Gaspé, which are not now suitable for jet operations. As a result of Quebecair's interest in serving the Gaspé with its BAC-111 jet instead of with the F-27 it now uses, a study has been initiated to identify the costs and benefits of necessary airport improvements. This study also considers, as an alternative, the use of the DASH-7 between the Gaspé and various other points served by Quebecair. For each alternative considered (F-27, BAC-111, DASH-7), quality of service, cost of infrastructure improvements and economic implications will be assessed.

Carriers might find use of the DASH-7 unattractive, however, if it were more costly than using an aircraft already in their fleet or acquiring a secondhand, conventional turboprop aircraft. This attitude on the part of the carriers is understandable, in view of the fact that they pay the full cost of the aircraft they operate, but generally only a small fraction of the cost of airport improvements.

Yet the *total* cost of improved air service — infrastructure cost *plus* carrier costs — could in some cases be lower using the DASH-7, even if it were the more expensive aircraft, where it would obviate costly airport improvements. In some of these cases, it might be in the public interest for the federal government to assist a carrier in the acquisition of the DASH-7 in order to both improve the quality of air services and keep *total* government cost to a minimum.

STOL SERVICES TO URBAN CENTRES

There are two main areas where STOL aircraft could be utilized to provide commercial air service between urban centres already having well-developed airport facilities capable of supporting jet operations. The most widely discussed and thoroughly studied of the two is the *Downtown STOL System*, in which STOL aircraft would be used to link one or more downtown STOLports with STOLports or conventional airports in other cities.

Use of Short Runways at Conventional Airports

The other potential urban application of STOL aircraft would be in providing service between conventional airports, utilizing special short runways. This type of urban STOL application may have good potential in cases where the diversion of traffic from CTOL to STOL would result in reduced runway congestion at overcrowded airports.

Several factors would have to be taken into account in assessing the merits of a specific application of this concept. These would include air and ground traffic control considerations, capital and operating costs associated with any STOL infrastructure required, effects on runway capacities and delays, impacts on airport noise levels, implications for air carrier costs and consequences for the timing and cost of new or expanded conventional airport facilities.

Although de Havilland of Canada has identified several major airports in the United States where the DASH-7 could be effectively used in this capacity, there are at present no clear applications of the concept in Canada. The concept will be considered in the course of airport planning, however, as one potential means of reducing runway demand at those Transport Canada airports where runway congestion is a problem.

Downtown, Intercity STOL

There has been extensive discussion over the past decade of the merits of establishing a *downtown, intercity STOL* service in Canada to complement conventional jet services on short-haul routes. Until the certification of the DASH-7, however, there has been no aircraft available which could be effectively used in this type of application. A decision may now be appropriate as to whether Canada will be the first to implement this new concept of short-haul air transportation.

A number of factors should be considered before this decision is taken. Subject to possible fiscal restraints, an intercity STOL system could be judged appropriate where, on balance, the advantages associated with the following eleven principal factors were judged to outweigh the disadvantages:

(1) **NEED FOR TRANSPORTATION SYSTEM**

Is there a need, or a demand, for such a transporation system? Have Canadian air carriers expressed an interest in providing such a service?

(2) **AVAILABILITY OF SUITABLE AIRPORTS**

Do airports now exist which could be used in support of STOL services, considering aeronautical zoning requirements, air traffic management considerations and proximity to urban centres? If so, what infrastructure improvements would be necessary to support anticipated levels of STOL traffic volume? What would be the capital cost of such improvements? Where no suitable existing airports are available, are there any suitable sites available for the construction of a STOLport? If so, what are the estimated development costs of each? What are the advantages and disadvantages of each of the possible sites?

(3) **POLICIES, OBJECTIVES AND PLANS OF OTHER LEVELS OF GOVERNMENT**

Would the establishment of an intercity STOL system be compatible with, and supportive of, policies, objectives and plans of the provinces, regions and municipalities affected?

(4) **ALTERNATIVES INVOLVING OTHER MODES**

Should improvements in other intercity modes be considered as alternatives to the establishment of the STOL system?

(5) **COMMERCIAL VIABILITY**

Could user charges be set at a level which would both allow the government to recover all capital and airport operating costs and allow the STOL air carrier(s) to make a reasonable return on their investment?

(6) **ECONOMIC IMPLICATIONS**

Does the proposal represent an efficient use of the nation's resources, considering both transportation and non-transportation costs and benefits?

(7) **ENVIRONMENTAL IMPLICATIONS**

What would be the probable environmental consequences, in terms of noise, air and water pollution, impact on vegetation, wildlife and aquatic life, and energy conservation?

(8) **EFFECTS ON CONGESTION AT CONVENTIONAL AIRPORTS**

To what extent would the diversion of conventional short-haul air traffic to STOL reduce congestion at existing conventional airports and/or allow postponement of the construction of new, conventional airport facilities?

(9) **IMPLICATIONS FOR CANADIAN AIR CARRIERS**

What would be the impact on the domestic air carrier industry?

(10) **AEROSPACE INDUSTRY IMPLICATIONS**

What would be the probable direct and indirect effects on long-term DASH-7 sales? What would be the effect on employment in Canada's aerospace industry?

(11) **IMPLICATIONS FOR ECONOMIC DEVELOPMENT**

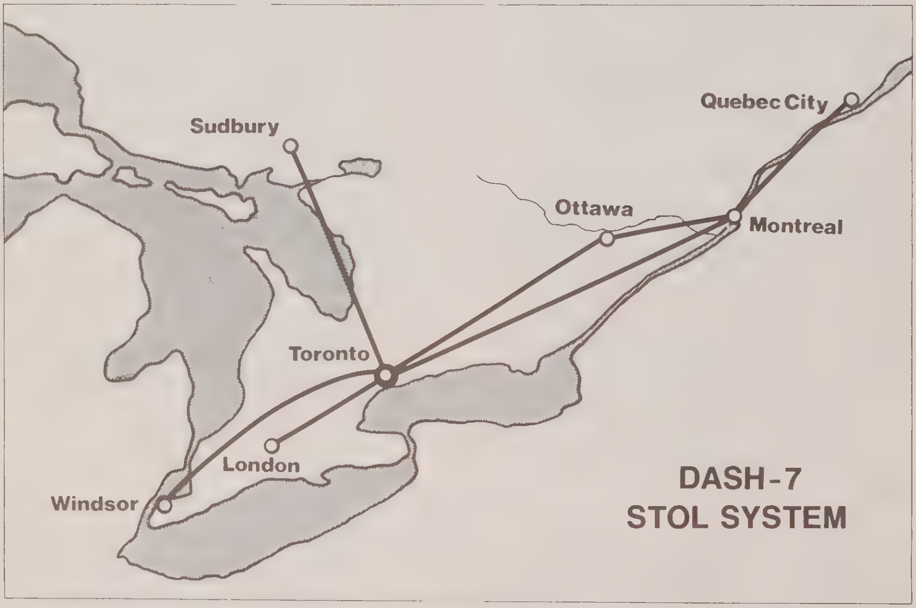
Would the development of an intercity STOL system further economic development objectives?

Potential Downtown, Intercity STOL Applications in Canada

There are three areas in Canada where the establishment of a downtown, intercity STOL system has been suggested: between Vancouver and Victoria, between Calgary and Edmonton, and in the Quebec-Windsor corridor. The first two have not been carefully assessed against each of the eleven principal factors identified above. They are dealt with here only in a preliminary manner.

Vancouver-Victoria

A *downtown-to-downtown* Vancouver-Victoria STOL service would offer substantial improvements in the quality of air services between the two cities, but the cost of STOL facilities in both cities together would be very high in relation to the number of passengers using the STOL service. (This assumes a suitable downtown Vancouver STOLport site could be found. Previous studies have identified the Canadian National/Great Northern railyards in the False Creek area as the only downtown Vancouver site that might be acceptable on environmental and technical grounds. STOLport construction costs at this location would be extremely high owing to the need to elevate the entire structure on concrete columns.)



A STOL service between Vancouver International Airport and a downtown Victoria STOLport appears to have greater potential than one requiring the construction of downtown STOLports in both cities. Such a proposal is being examined by the federal and British Columbia governments, as part of a joint study principally concerned with ways of improving air service between Vancouver and Victoria. The main problem appears to be the high cost of constructing a STOLport in downtown Victoria. Only two potential sites have been identified and both would probably be costly to develop.

Calgary-Edmonton

Calgary-Edmonton is very well served by Pacific Western Airlines' highly efficient "airbus" service between the downtown Edmonton Municipal Airport and Calgary International using Boeing 737 aircraft. It is unlikely that a DASH-7 STOL service could offer significant door-to-door trip-time savings over the PWA jet service, regardless of whether STOL services were based at existing airports, or at specially-constructed downtown STOLports. As STOL fares would not likely be lower than CTOL fares *on that route*, a STOL service probably could not compete effectively.

Although there would be other considerations to take into account in weighing the pros and cons of a STOL service between Calgary and Edmonton (such as noise reductions), it does not appear that the potential benefits, in relation to the costs, are as great as they would be in the Quebec-Windsor corridor.

Quebec-Windsor Corridor

The Quebec-Windsor corridor is the one area of Canada where there has been a thorough examination of the various factors that should be considered in deciding whether to establish a downtown, intercity STOL system. The results of this examination are discussed in the next section.

Section 5

Intercity STOL in the Quebec ~ Windsor Corridor

SECTION 5
Intercity STOL in the Quebec-Windsor Corridor

This Section is devoted to a discussion of the advantages and disadvantages of establishing a downtown, intercity STOL system in the Quebec-Windsor corridor, in the context of the eleven principal factors identified in Section 4. This discussion is meant to be useful and informative to decision-makers, but does not attempt to answer the basic question: Should an intercity STOL system be established in the Corridor? To do so would require a weighting of each of the eleven factors to be considered, a decision that can only be made by the policy-makers themselves.

STOL SYSTEM ALTERNATIVES

A number of possible STOL systems could be considered for the Quebec-Windsor corridor. Two examined in connection with the Toronto Island Airport Study Program were identified as *Regional STOL* and *Extended STOL*.

- *Regional STOL* involves the use of Toronto Island Airport as the "hub" for regional "hub and spoke" STOL services to existing, conventional airports in London, Sarnia, Windsor, Sudbury (with connections to northern Ontario), Kingston and St. Catherines.
- *Extended STOL* represents a major expansion of *Regional STOL* by the addition of STOL services to Montreal and Ottawa. Both of these alternatives involve the use of both DASH-7 and Twin Otter STOL aircraft.

The appended Transport Canada study "Economic Evaluation of a Downtown, Intercity STOL System in the Quebec-Windsor corridor" — hereafter referred to as the *Transport Canada Economic Study* — examined the economics of two long-term STOL system alternatives which are similar to the *Extended STOL* alternative described above.

- The *Two STOLport Option* would involve the construction of downtown STOLports both at Toronto Island and in Montreal at Victoria Carpark (the Montreal terminus for the Airtransit Demonstration STOL service). DASH-7 services would be provided between Toronto island and Victoria Carpark, between Toronto Island and conventional airports in Ottawa, London, Windsor and Sudbury, and between Victoria Carpark and conventional airports in Ottawa and Quebec City.
- The *Single STOLport Option* involves the construction of a STOLport at Toronto Island Airport only, with DASH-7 STOL services linking Toronto Island with existing conventional airports in Montreal,

Ottawa, London, Windsor and Sudbury.

Other studies have assumed different combinations of STOLports, conventional airports and corridor routes. For example, a study carried out by Air Canada in 1975 assumed that, at least initially, STOL services would be confined to the Montreal-Ottawa-Toronto triangle and that downtown or near-downtown STOLports would be constructed in each of these cities.

The common denominator among all of these studies is the central and essential role played by Toronto Island Airport as the STOL terminus in Toronto. Toronto Island Airport is the most practical STOLport site in the vicinity of downtown Toronto. Consequently, the question of whether an intercity STOL system should be established in the Quebec-Windsor corridor is completely bound up with the question of the future use of the Toronto Island Airport site.

STOLPORT CAPITAL COSTS
(millions of 1976 dollars)

	VICTORIA CARPARK (MONTREAL)	TORONTO ISLAND AIRPORT
Access	0.2 (road)	3.9 (pedestrian tunnel)
Parking	0.5 (ground level)	3.5 (structure plus land cost)
Site Preparation (demolition, drainage and grading)	16.7	1.1
Air Terminal Building	3.3	3.5
Maintenance Garage	0.5	0.5
Pavement (incl. runways, taxiways and aprons)	1.0	2.2
Utilities (power, electrical gas, water and sewer)	1.4	1.9
Control Tower, Radar and Navigational Aids	2.4	2.4
Management, Development and Coordination	4.0	1.8
Contingencies	5.2	– (incl. above)
Equipment and Machinery	0.7	0.7
TOTAL	35.9	21.5

FACTORS TO CONSIDER

The following discussion of an intercity STOL system in the Quebec-Windsor corridor generally applies to all of the various options that might be considered. It will be made clear in the text when the discussion applies only to certain options.

(1) Need for Transportation System

On the basis of the demonstrated and expressed preferences of Airtransit's passengers, studies done by Transport Canada, de Havilland of Canada, and several Canadian air carriers (including Air Canada), it can be concluded that there would be a substantial demand for an intercity STOL service in the Quebec-Windsor corridor. This conclusion is also supported by the tentative interest that two of Canada's regional air carriers, Nordair and Quebecair, have expressed in operating certain of the STOL routes.

The actual volume of STOL traffic realized would, of course, depend greatly upon which routes would be served, whether Montreal STOL services would be based at Dorval Airport or at the Victoria Carpark site, the level of STOL fares (including user charges) vis-à-vis fares for other modes, the extent and nature of competition between STOL and CTOL services and numerous other factors. There appears to be a general consensus, however, that if STOL services were established in the Montreal-Ottawa-Toronto triangle a substantial number of intercity travellers would choose to travel within the Corridor by STOL rather than by other modes. It is expected that, on a system-wide basis, more than 75% of all STOL passengers would be diverted from CTOL.

(2) Availability of Suitable Airports

As noted previously, Toronto Island Airport has been identified as the most practical 'downtown' or 'near-downtown' STOLport site in the Toronto area. Except for the problem of providing improved access, the Toronto Island site is ideal for STOL operations. The site is close to downtown Toronto; there are no existing or potential aeronautical zoning problems; and noise levels over inhabited areas would not be affected.

In Montreal, STOL operations could be based either at Dorval Airport or at Victoria Carpark. The Victoria Carpark location would result in greater time savings for STOL users, but this advantage would be offset by certain disadvantages, the most important being high capital costs for the construction of the STOLport and increased costs of a Hydro Quebec power project because STOL operations would impose restrictions on the placement of power transmission lines.

Two other potential STOLport sites in Montreal were considered — St. Hubert airport and a vacant property in LaSalle — but rejected, because they were judged to be too far from the city centre and would have posed severe air traffic control problems. Moreover, the LaSalle site was judged to be too close to nearby residential areas.

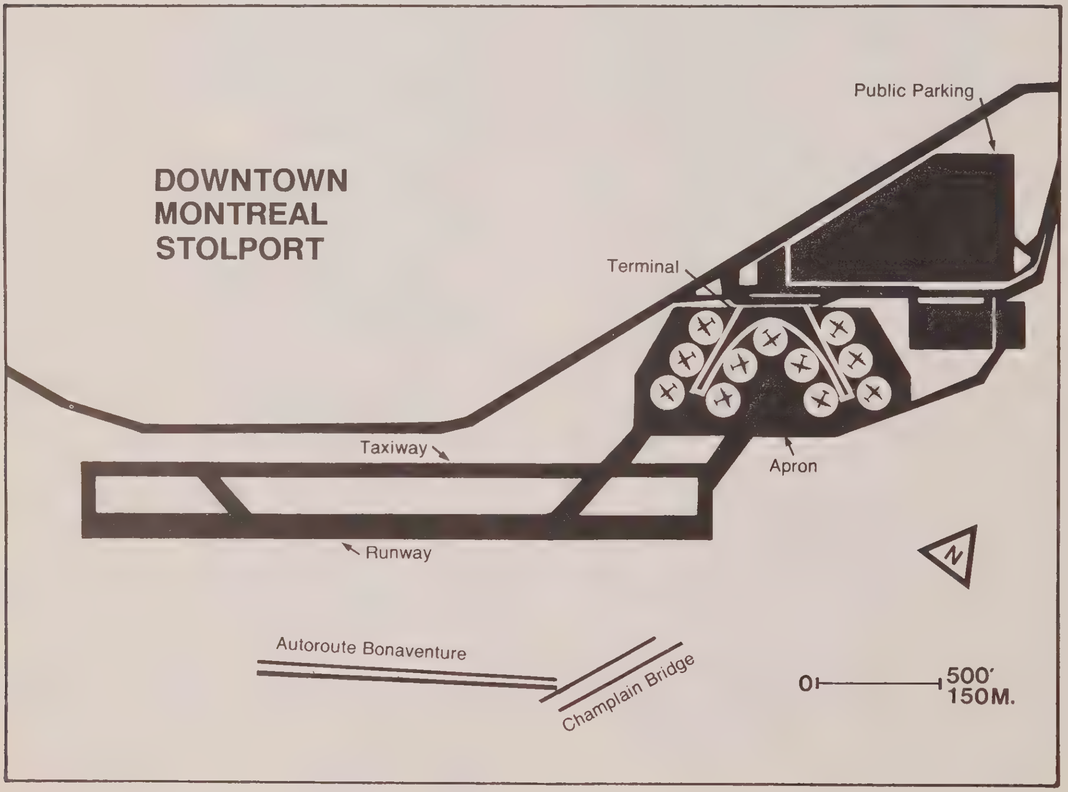
Capital cost estimates for the Toronto Island and Victoria Carpark STOLport facilities are shown in the table on the opposite page. These cost estimates are based upon a major STOL system concept, with 1990 design capacities of 1.8 million passengers annually for the Toronto Island STOLport, and 1.5 million passengers annually for the Victoria Carpark STOLport.

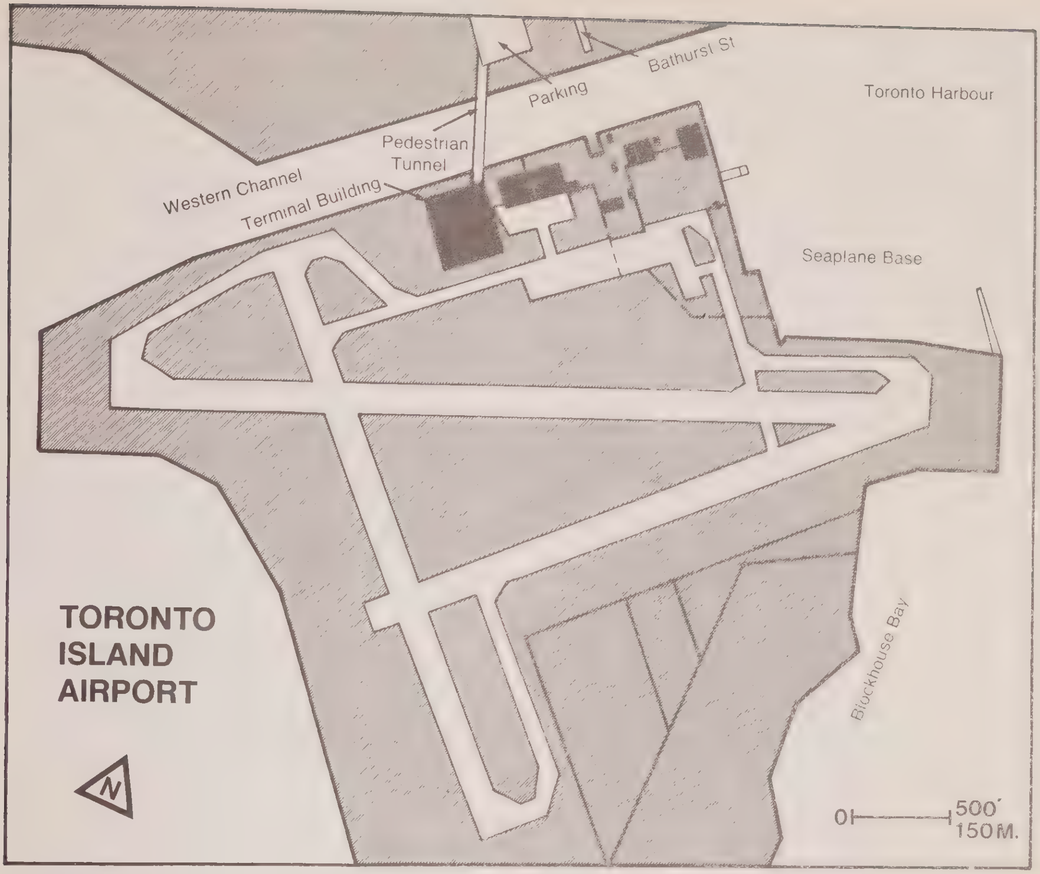
The high capital cost associated with the Montreal site is largely due to the probable need for a massive excavation and fill operation to provide a proper footing for the runway, taxiway, apron and buildings. The site is a former garbage dump. The decomposition of organic material results in both a highly unstable surface and in the release of methane gas. The only satisfactory design solution for establishing a permanent STOLport facility may be to remove the garbage (averaging thirty feet deep) and replace it with suitable fill in those areas where a sturdy base would be essential. An engineering study is in progress to determine the most cost-effective solution to this problem.

In addition to capital costs, annual operating and maintenance costs (in 1976 dollars) have been estimated at $1.9 million for the Toronto Island STOLport and $1.4 million for the Victoria Carpark STOLport.

It has been concluded that there would be no significant increase in either capital or operating costs as a result of basing STOL operations at conventional airports.

A more complete discussion of capital and operating costs for the Toronto Island and Victoria Carpark STOLports is contained in the Transport Canada technical reports prepared for the *Toronto Island Intergovernmental Staff Forum* (Study 3), and in the *Transport Canada Economic Study*.





(3) Policies, Objectives and Plans of Other Levels of Government

The Government of Ontario, the City of Toronto, Metro Toronto and the Toronto Harbours Board have had a special interest in the possible establishment of a downtown STOL system in the Corridor, because of the implications it would have for intercity transportation services in Ontario, for the future use of the Toronto Island Airport site and also because of the positive effect that it would have on employment levels at one of Southern Ontario's major manufacturing firms, de Havilland of Canada, maker of the DASH-7.

In view of the wide interest in the future use of the Toronto Island Airport property, the *Toronto Island Intergovernmental Staff Forum* was established in 1975, for the purpose of identifying alternative future uses for the site, and assessing the social, financial, economic and environmental consequences of each proposed use. The *Staff Forum* consisted of public officials from interested federal, provincial and municipal governments.

A *Policy Steering Group* was also established to give direction as necessary to the activities of the *Staff Forum*. This group consisted of the Minister of Transport, the Minister of State for Urban Affairs, the Minister of Transportation and Communications of the Province of Ontario, the Mayor of Toronto, the Chairman of Metro Toronto and the Chairman of the Toronto Harbour Commissioners.

At the federal level, Transport Canada carried out numerous technical studies related to the three aviation uses being examined:

- general aviation only,
- general aviation plus regional STOL, and
- general aviation plus extended STOL.

The Ministry of State for Urban Affairs worked with the City of Toronto in assessing four non-aviation uses:

- regional parkland,
- marine life and parkland,
- major residential community, and
- low density housing plus parkland.

The public had an opportunity to ask questions about these studies and to comment on their completeness and validity at a series of public workshops.

The *Staff Forum* sponsored a final conference on May 13-14, 1977 to give the public an opportunity to discuss the advantages and disadvantages of each proposed use for the site and to express their preferences on how the site should be used. Members of the Policy Steering Committee attended the second day of the Conference.

In parallel with the work of the *Staff Forum*, Transport Canada and Ontario's Ministry of Transport and Communications have been working together on a series of multi-modal transportation planning studies. The *Southern Ontario Multi-Modal Passenger Studies* deal with major transportation issues involving all modes.

One of the studies, which is to be completed in late Spring, 1978, considers alternative transportation supply strategies for Southern Ontario. Basically, this study attempts to identify the various ways in which future demand for intercity travel within and beyond Southern Ontario can be met between now and 1991. The establishment of a Toronto Island-based intercity STOL system is being considered as one component of certain of the proposed supply strategies.

It is only through the process of joint planning and consultation that the policies, objectives and plans of different levels of government can be fully understood, discussed and any conflicts resolved. The federal government, through its participation in the *Toronto Island Intergovernmental Staff Forum* and in the federal-provincial *Southern Ontario Multi-Modal Passenger Studies*, has demonstrated its concern that a decision on the possible establishment of a corridor STOL system should not be taken until the alternatives and their implications had been thoroughly studied and fully discussed with all levels of government concerned.

(4) Alternatives Involving Other Modes

Other intercity transportation alternatives to STOL in the Corridor have been considered, though not in great detail. Among these, the transportation alternative most often suggested is improved passenger rail service.

Improved rail service in the Corridor would likely take the form of speed-related improvements to existing rail infrastructure and the greater use of Turbo or LRC (light, rapid and comfortable) trains. It would be technically feasible to construct new high-speed rail lines on dedicated tracks that would permit use of equipment capable of maximum speeds of up to 250 Kilometres per hour, but the capital cost alone would be extremely high. In view of the heavy infrastructure and equipment costs required for such a high-speed rail system, and the limited potential traffic volumes (compared with those transported by high-speed, intercity passenger rail systems in Japan, England and France), it seems unlikely that this type of high-speed intercity passenger rail service will be established in the Quebec-Windsor corridor in the foreseeable future.

With the exception of the Montreal-Toronto route, substantial improvements in passenger rail services could be made on most corridor routes for relatively small expenditures. The existing Montreal-Toronto service now has relatively good frequency (seven trains daily each way) and fast trip times (four hours, ten minutes, for the twice daily Turbos). Improvements on this route would be extremely costly and less cost-effective than improvements on the other corridor route segments.

On the basis of door-to-door travel time estimates for improved rail, CTOL and STOL, it has been concluded that STOL and improved rail would compete for the business travel market on the Montreal-Ottawa and Toronto-London routes. Limited competition might exist between STOL and improved rail on the Montreal-Quebec and Toronto-Windsor routes, but in both cases door-to-door travel time (one-way) would be at least one and one-half hours less with STOL than with improved rail. Considering also the relatively small differences in estimated door-to-door travel time between STOL and CTOL on these two routes (11 minutes and 7 minutes, respectively), it would seem unlikely that the introduction of STOL on these routes would substantially affect the volume of improved passenger rail traffic. Very little competition would be expected between STOL and improved rail on the two longest routes — Toronto-Montreal and Toronto-Ottawa — in view of the large door-to-door time savings of STOL over improved rail and comparatively small differences in door-to-door travel times between STOL and CTOL.

Thus, with the exception of the Montreal-Ottawa and Toronto-London routes, it seems likely that improved rail service would generally serve a different market than STOL. Since these two routes would together only account for approximately 8%-17% of the total, system-wide STOL traffic volume, it has been concluded that the proposed Corridor STOL and improved rail services can reasonably be viewed as complementary rather than competing services. The adoption of either transportation system would not significantly influence the desirability of adopting the other as well.

(5) Commercial Viability

Whether a STOL system would require a subsidy, either directly or indirectly, is a complex question. Studies done by Transport Canada and Air Canada indicate that if STOL passengers and carriers were subject to the same user charges as are now imposed on air passengers and carriers, a STOL carrier could probably show a modest profit, although the revenues collected would be insufficient to cover fully the costs of providing and maintaining the STOLport(s) and other STOL infrastructure. It is not certain what the impact on traffic and carrier profitability would be if user charges were increased to recover all STOLport and other infrastructure costs. Within the range of fares tested by the Airtransit Demonstration, demand for service appeared to be relatively price insensitive. STOL fares sufficient to cover all infrastructure costs might therefore be possible without seriously affecting patronage of the service.

(6) Economic Implications

A detailed cost-benefit study has been done in order to assess the overall economic implications of developing a DASH-7 STOL system in the Quebec-Windsor corridor. The results of the study are discussed in detail in the *Transport Canada Economic Study*.

The evaluation of the costs and benefits of STOL has been made in comparison with those associated with the modes which would likely be employed in the absence of STOL: CTOL, rail, bus and auto. The study assumes that without STOL, the Toronto Island Airport site would be used for a market-oriented housing development.

Principal Costs and Benefits

The principal economic cost of the STOL system is the *additional* cost of transporting STOL passengers over what it would cost to transport them by the modes which they would select if STOL were not available. These costs include both infrastructure and carrier costs and apply to the access/egress and intercity portions of trips.

The total transportation-related *benefit* represents the value of the resources which would be *saved* as a result of having STOL. In addition, the development of an intercity STOL system in Canada could well result in increased DASH-7 sales to foreign carriers. The difference between the return on the marginal investment required to produce the additional DASH-7 aircraft and the return that the same resources could produce in other sectors of the economy represents an economic benefit (or cost, if the difference were negative) which should also be attributed to the development of the STOL system in the Corridor.

The *Transport Canada Economic Study* estimates the magnitude of the costs and benefits, which may be expressed as three main resource costs and three principal types of benefits.

The principal economic costs are:

- *infrastructure costs,* which include land acquisition for STOLports, construction of STOLports, provision of access to STOLports, ongoing STOLport operations, grants paid to municipalities in lieu of taxes and opportunity costs of publicly-owned land used for STOLports;
- *increased transportation costs,* which equal the differences in the values of the transportation resources which

would be utilized (including ground transportation at the points of origin and destination) with and without STOL; and

- *increased cost of a Hydro Quebec power* project in the vicinity of the proposed downtown Montreal STOLport, owing to restrictions that would be imposed by STOL operations on the placement of power transmission lines. (Applicable to the *Two STOLport Option* only.)

The three principal benefits are:

- *trip time savings* realized by STOL users, taking into account time spent travelling to and from terminals, time spent in terminals before departure and after arrival and time spent travelling between terminals;

- *impacts on conventional airports,* which would apply particularly to Malton Airport, and which would take the form of reduced delays and congestion during the 1980-1990 time period and some delay in the need for new airport facilities in the Toronto area; and

- *increased DASH-7 sales* to the domestic carrier(s) who would operate the Corridor STOL system and to foreign carriers who would be swayed to purchase the aircraft, for both conventional and intercity STOL applications, by Canada's confidence in the aircraft and willingness to implement the intercity STOL system concept.

Secondary Costs and Benefits

In addition to these principal costs and benefits, several secondary considerations are discussed in the *Transport Canada Economic Study.* Perhaps the most important of the "secondary benefits" concerns the possible retention of general aviation at Toronto Island Airport. For an additional expenditure of approximately $2.1 million, general aviation facilities could be provided at the Toronto Island STOLport, an option not available if the site were used for some non-aviation purpose. The closure of Toronto Island Airport would hasten the need for a new general aviation airport in the Toronto area (at an estimated cost of $14 – $28 million, depending upon the airport's location).

STOL Route Network

It was determined that in the 1980-1990 planning period, DASH-7 STOL services could be provided on between five and seven routes in the Quebec-Windsor corridor. Estimates of the relative importance of each of these routes, in terms of estimated STOL passenger volumes, together with an estimate of the relative importance of existing modes as sources of STOL passengers, are given in the table on the next page. It is estimated that for the *Two STOLport Option*, 50% of all STOL passengers would be travelling on the Montreal-Toronto route and 79% of all STOL passengers (over all STOL routes) would be diverted from CTOL. For the *Single STOLport Option*, 55% of all STOL passengers would be expected to be travelling on the Dorval-Toronto route and 86% of all STOL passengers would be diverted from CTOL.

SOURCE OF STOL PASSENGERS, BY ROUTE

Route	Route Demand, as Percentage of Total STOL System Demand		Source of STOL Passengers, in Percentage Terms			
* denotes Downtown STOLports	Two STOLport Option	Single STOLport Option	CTOL	RAIL	BUS	AUTO
Montreal*-Toronto*	50	N/A	89	7	0	4
Dorval-Toronto*	N/A	55	93	5	0	2
Montreal*-Ottawa	12	N/A	35	10	24	31
Montreal*-Quebec	6	N/A	49	18	15	18
Toronto*-Ottawa	16	22	95	2	0	3
Toronto*-London	5	8	29	38	14	19
Toronto*-Windsor	5	6	59	34	1	6
Toronto*-Sudbury	6	9	87	8	1	4
Route Weighted Average						
Two STOLport Option			79	10	5	9
Single STOLport Option			86	9	1	4

DASH-7 STOL services might be provided on three transborder routes and Twin Otter services could be provided on certain other routes, but the inclusion of these routes in the analysis would have increased system-wide STOL passenger volumes only slightly and would not have altered the overall economic results appreciably.

Summary of Costs and Benefits

Estimates of the total economic costs and benefits for the two STOL system alternatives, expressed in present value terms, in total and per STOL passenger, are contained in the table on the next page. Depending on STOL passenger volumes, total economic costs over the ten-year period are estimated to exceed total benefits by \$50 – \$54 million for the *Two STOLport Option* and by \$32 – \$44 million for the *Single STOLport Option*. On a per STOL passenger basis, economic costs are estimated to exceed total benefits by \$6 – \$10 for the *Two STOLport Option* and by \$7 – \$8 for the *Single STOLport Option*.

Sensitivity of Results

Two measures of the sensitivity of the total net economic disbenefits to errors in the estimation of costs and benefits are contained in this table. The first of these are the 80% "confidence ranges". These ranges are expected to contain the actual net economic disbenefit with a probability of 80%. This is equivalent to saying that it is estimated that there is only a 10% chance that the actual net economic disbenefit is below the "lower limit" and an equal likelihood that it is above the "upper limit". The second sensitivity measure is the estimated probability that total costs exceed total benefits (i.e., that the net economic disbenefit is positive), which is given in the last line of the table.

PRINCIPAL ECONOMIC COSTS AND BENEFITS

(Present Values, in $1976)

	Two STOLport Option		Single STOLport Option	
	Total	Per STOL Passenger	Total	Per STOL Passenger
ECONOMIC COSTS				
– Infrastructure Costs	$ 61M	$ 7-11	$ 28M	$ 4-7
– Opportunity Cost of Toronto Island Airport Site (1976-1990)	$ 30M	$ 3-6	$ 30M	$ 5-8
– Increased Transportation Costs	$ 59M-100M	$11	$ 43M-72M	$11
– Increased Cost of Hydro Quebec Project	$ 10M	$ 1- 2	–	–
Total Economic Costs	$160M-201M	$22-29	$101M-130M	$20-26
ECONOMIC BENEFITS				
– Travel Time Savings	$ 53M-91M	$10	$ 19M-31M	$ 5
– Benefit to CTOL Airports				
– Reduced Congestion	$ 3M-5M	$ 1	$ 1M-2M	–
– Delay in Expenditure for New Airport	$ 8M-13M	$ 1	$ 7M-11M	$ 2
– Industrial Benefits	$ 42M	$ 4-7	$ 42M	$ 6-11
Total Benefits	$106M-151M	$16-19	$ 69M-86M	$13-18
NET ECONOMIC DISBENEFIT				
– Estimated Value	$ 54M-50M	$ 6-10	$ 32M-44M	$ 7-8
– 80% Confidence Range				
lower limit	-$ 10M	-$ 1	-$ 8M	-$ 2
upper limit	$115M	$16	$ 84M	$17
– Probability Costs Exceed Benefits	82%-90%		83%-87%	

Conclusions of Economic Analysis

The *Transport Canada Economic Study* concluded that for both options considered, it is probable that total economic costs exceed total economic benefits. This means that, barring major errors in the estimation of costs and benefits, a STOL system in the Quebec-Windsor corridor cannot be supported on economic grounds, when compared with the base case alternative: namely, the continuation of service by existing transportation modes in the Corridor and development of the Toronto Island Airport site for market-oriented housing.

It should be noted, however, that the City of Toronto Planning Board has concluded that the base case market-oriented housing alternative would be incompatible with the City's housing policies. Consequently, the conclusion that the total economic costs of STOL would probably exceed the total economic benefits does not mean that on economic grounds STOL would be a less desirable use of the Toronto Island Airport site than other uses that have been proposed. To make a meaningful comparison of the economic implications of the various proposed uses for this site, it would be necessary to carry out a cost-benefit study for each. Although this has not been done, it is possible to make a rough comparison between an intercity STOL system and two of the four non-aviation alternatives that have been proposed.

On the basis of financial information contained in the document, "Alternative Non-Aviation Uses," (Toronto Island Study Program, Study Four), it appears that economic costs would exceed economic benefits for both the *Major Residential Community* and the *Pedestrian Community and Parkland* alternatives (Scenarios "C" and "D"). Although it is difficult to estimate the benefits associated with each of these alternatives, it is estimated that when compared with the base case alternative, these two alternatives have net economic disbenefits (in total present value terms) of approximately $10-20 and $20-30 million respectively. This compares with estimated net economic disbenefits for the two STOL system alternatives of $32-44 million and $50-54 million, less the (unestimated) economic benefits associated with the retention of general aviation at Toronto Island Airport.

Insufficient information is available to estimate the economic benefits associated with the proposed *Regional Parkland* (Scenario "A"), *Marine Life Park and Parkland* (Scenario "B") and *General Aviation Only* uses for the Toronto Island Airport site.

(7) Environmental Implications

The probable environmental impacts of developing and operating an intercity STOL system in the Quebec-Windsor corridor have been assessed and were found to be relatively insignificant. This conclusion is based upon the results of studies done for the *Intergovernmental Staff Forum* of the likely environmental impacts of using Toronto Island Airport for intercity STOL and general aviation operations, on the results of surveys of reactions to the Airtransit Demonstration Service among residents in the vicinity of the Rockcliffe and Victoria Carpark STOLports, and on estimates of the probable implications of a STOL system on total energy requirements for all transportation modes operated in the Quebec-Windsor corridor.

The studies concerned with the environmental consequences of using the Toronto Island Airport site for STOL and general aviation operations examine impacts on air quality, noise and water quality, vegetation, wildlife and aquatic life. They conclude that the development of an intercity STOL system would result in very little environmental impact in the vicinity of the Toronto Island Airport site.

Although the results of these studies pertain only to the Toronto Island site, it can reasonably be assumed that environmental effects would also be acceptable in the vicinity of Victoria Carpark. Moreover, the results of surveys of residents living in the vicinity of Victoria Carpark, conducted during the Airtransit Demonstration Service, further support the conclusion that local residents would probably have little negative reaction to a permanent STOL system based there.

It is expected that the introduction of STOL services at existing conventional airports might result in a slight positive environmental impact, due to the possible displacement of some conventional jet operations by relatively quiet DASH-7 STOL operations. Similarly, a diversion of some conventional air traffic to the Toronto and Montreal STOLports might reduce slightly noise levels in the vicinity of Malton and Dorval airports.

It is estimated that the development of an intercity STOL system in the Quebec-Windsor corridor would result in a total transportation-related energy saving of approximately one to one and one-half gallons of fuel per STOL passenger, per one-way trip, for an average per STOL passenger fuel saving of approximately 11%-14% and a total average annual fuel saving of approximately 1-2 million gallons.

(8) Effects on Congestion at Conventional Airports

The impact of a diversion of CTOL traffic to STOL on delays and congestion at Malton and Dorval Airports would be greatest at Malton, where significant delays and congestion are becoming increasingly severe. STOL's main contribution would be in the reduction of peak-hour demand for runway use during periods when wind conditions restrict operations to a single runway.

A runway delay analysis has shown these benefits to be relatively small, however. Other benefits related to STOL's effects on congestion levels at conventional airport facilities would be of less significance. In particular, a reduction in CTOL flights would only provide minor relief to the terminal congestion problem at Malton and would result in at most a slight reduction in noise levels at Malton and Dorval.

It is estimated that diversion of CTOL traffic to STOL on the scale postulated in the *Transport Canada Economic Study* would permit postponement of the construction of additional conventional airport facilities in the Toronto area by two to four months. This would represent an economic benefit of $7 – 11 million (in present value terms), which was accounted for in the economic analysis discussed earlier.

(9) Implications for Canadian Air Carriers

The question of which carrier(s) would operate the STOL system should properly await a decision in principle on whether the STOL system should be developed at all. It is possible, however, to estimate the probable effect that the development of the STOL system would have on Canadian air carriers, depending of course upon which carrier(s) would be involved in the operation of the STOL system.

It is uncertain whether Air Canada would gain or lose financially by the introduction of STOL services. In 1975, Air Canada conducted a detailed STOL feasibility study (which was made available to the *Toronto Island Intergovernmental Staff Forum*), which concluded that if operated by an air carrier having the cost structure of a regional or local air carrier, a STOL service could be profitable.

The analysis contained in the *Transport Canada Economic Study* suggests that as a result of a diversion of CTOL traffic to STOL, Air Canada's costs of providing conventional air services would decline by an amount less than the associated reduction in revenues. If this conclusion is correct, it means that the profitability of Air Canada's conventional air services would decrease as a result of the introduction of STOL and that this would ultimately be reflected in higher conventional air fares.

Air Canada has not carried out the analysis necessary to support or refute this finding. If such a study were to prove the above conclusion incorrect, that is, that the reduction in Air Canada's cost on routes served by STOL would be greater than the associated reduction in revenues, then the resulting improvement in the profitability of Air Canada's conventional air services could be attributed to the introduction of STOL service in the Corridor. However, even if this were so, the benefit would not be sufficient in itself to eliminate the estimated net economic disbenefit previously mentioned.

Quebecair, which has expressed tentative interest in providing STOL services on the Montreal-Quebec route (to augment its existing CTOL service on that route), would benefit if it were licensed to do so, but would be adversely affected if another carrier were given the route instead. Any other Canadian carrier(s) licensed to provide STOL services in the Corridor would probably benefit financially. Other Canadian carriers would not be significantly affected.

(10) Aerospace Industry Implications

The development of an intercity STOL system in Canada could have two important effects on foreign DASH-7 sales. First, it should help to demonstrate that the aircraft will be produced in substantial numbers and that the Canadian government and Canadian carriers have confidence in it. This, it has been argued, would cause a number of foreign carriers who have shown interest in the airplane to place firm orders, thereby establishing a "launch market" for the aircraft, which is important to the success of the DASH-7 program. Without a Canadian STOL system, the launch market would likely be slower in developing, and as a consequence, the total number of DASH-7 sales would be less.

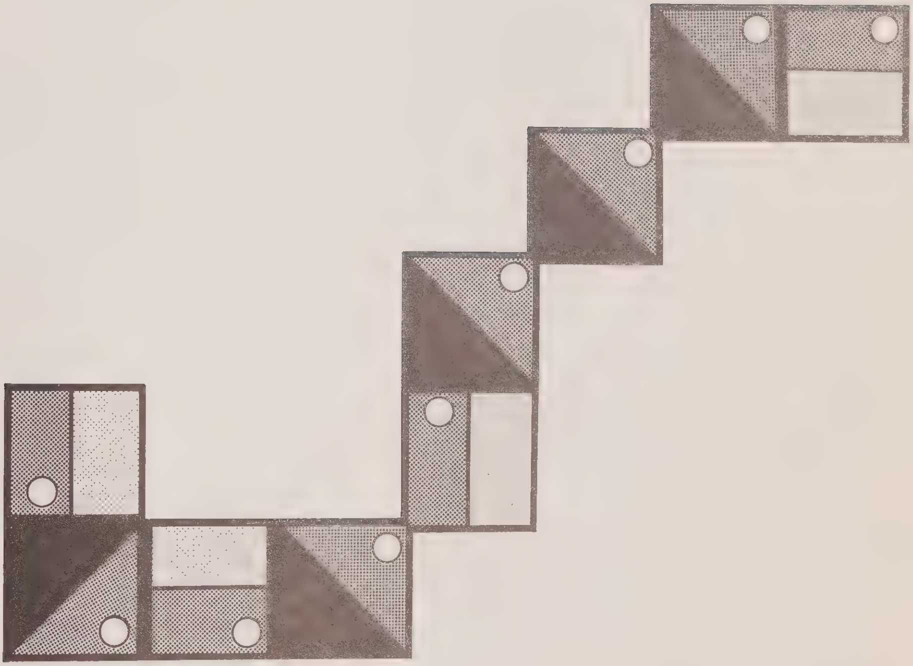
The existence of a Canadian high-density intercity STOL system could also have a positive effect on the development of similar high-density intercity STOL systems in other countries. Such systems would be less likely to develop without the feasibility and commercial viability of the concept being proven in Canada first. Once in place, successful operation of the Canadian system could be the necessary catalyst for the concept to gain approval elsewhere.

In addition to the purely economic implications, the additional DASH-7 sales which would be generated would increase and prolong employment at de Havilland and at its many Canadian suppliers. It would also strengthen de Havilland financially and thereby improve the value of its government-held shares.

(11) Implications for Economic Development

It has been suggested that the development of an intercity STOL system in the Quebec-Windsor corridor might support economic development objectives in Quebec and Ontario. It is argued that the provision of STOL services between small centres in Quebec and Ontario and downtown STOLports in Toronto and Montreal would improve accessibility to these communities and thereby help to promote their economic development.

It must be recognized, however, that for small centres that now enjoy conventional air services, the introduction of STOL services to downtown Montreal and Toronto would likely result in a reduction in the frequency of conventional air services to Malton and Dorval Airports. This would mean some inconvenience for air travellers connecting to other flights in Toronto and Montreal. This disadvantage of STOL would have to be set against the advantage of better frequency and convenience that STOL services would provide for people travelling between small centres and downtown Montreal or Toronto.



Section 6

Conclusions

SECTION 6
Conclusions

The aim of this report has been to describe the contribution that the STOL concept could make in meeting Canada's needs for short-haul commercial air transportation. As such, it has outlined the principal applications of the STOL concept, and the steps taken by the Government of Canada and the Canadian aerospace industry to develop these ideas.

A number of points have been demonstrated. First, it has been shown that it is possible to build a relatively large aircraft of undisputed technical excellence that satisfies the essential requirements of the STOL concept: short-field capability, quietness of operation and general environmental acceptability. Now that a STOL aircraft of this size is available, it is possible to implement the STOL concept in all its facets.

Secondly, it has been shown that there are potential benefits to be realized through the greater use of STOL aircraft in providing air services to isolated communities in the North and to small communities and regional centres in Southern Canada. In such services, there appears to be a role for both STOL and conventional aircraft; the DASH-7 serves both roles equally well.

Finally, consideration has been given to the possible establishment of a *downtown intercity STOL system* in Canada using DASH-7 aircraft. There are three areas in Canada where the establishment of a *downtown, intercity STOL system* has been suggested: between Vancouver and Victoria, between Calgary and Edmonton and in the Quebec-Windsor corridor. Of these possibilities, the last is the only one that has thus far been investigated in detail, although a study is in progress for the Vancouver-Victoria route. Eleven principal factors were identified against which any proposed application of this kind could be assessed.

The possible establishment of a STOL system in the Quebec-Windsor corridor was assessed against these factors. It was found that there would be a substantial demand for STOL services among business travellers, that a STOL service could be commercially attractive for the STOL carrier and that the capital and operating costs of the STOLport facilities probably could be recovered from STOL users.

Furthermore, it was concluded that the establishment of a corridor STOL system would help to relieve congestion at Malton Airport, could help to postpone, for a short time, the need for major new airport facilities in the Toronto area, would be acceptable from an environmental point of view, and would have a positive effect on the domestic aerospace industry. It is forecast that more than 75% of all STOL passengers

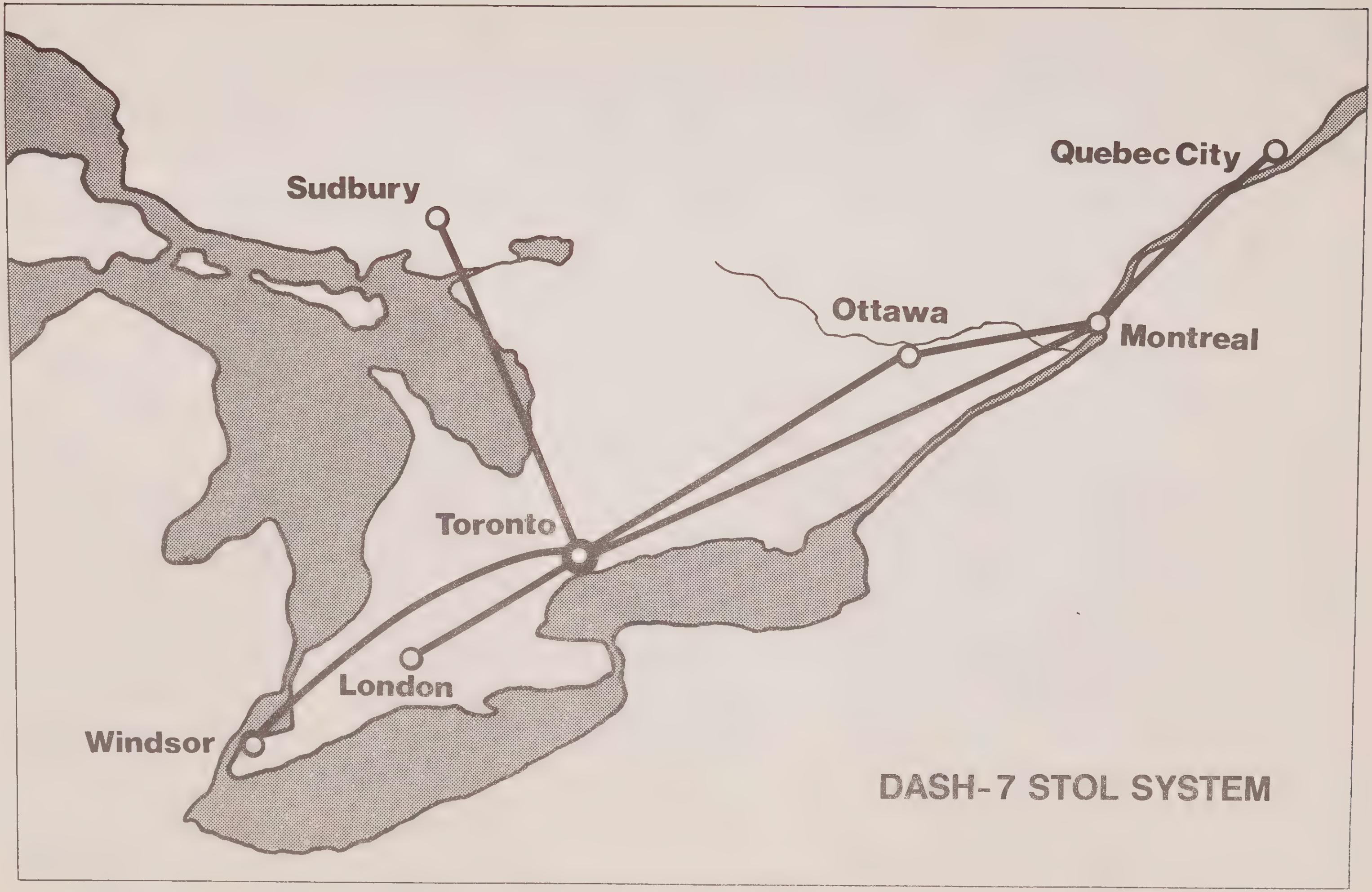
would be diverted from conventional air services, with traffic on surface modes of transport being relatively unaffected.

It was estimated that the economic costs of introducing a permanent, high-density STOL system in the Quebec-Windsor corridor would probably exceed the economic benefits. This conclusion should be treated with care, however, because of the impossibility of measuring definitively many of the costs and benefits involved (for example, the cost of forgoing use of the Toronto Island Airport site for non-aviation purposes, and the benefit to be ascribed to time savings). In addition, some allowance should also be made for the economic benefit (not estimated) to be derived from continued use of Toronto Island Airport by general aviation, in conjunction with STOL. The true economic results could thus deviate very significantly, in either direction, from the net disbenefit estimated. From an economic point of view, STOL could represent a more desirable use of the Toronto Island Airport site than other non-aviation uses which have been proposed.

For the past three years, the federal government has cooperated with other governments and local interest groups in an effort to assess fully all of the advantages and disadvantages of making the Toronto Island Airport available as the hub for a STOL service network in the Quebec-Windsor corridor. This report is intended as a further contribution in the process leading to a decision on this important question of public policy.

Annex

Economic Evaluation of a Downtown, Intercity STOL System in the Quebec~Windsor Corridor


Quebec City
Sudbury
Ottawa
Montreal
Toronto
London
Windsor
DASH-7 STOL SYSTEM

SUMMARY AND CONCLUSIONS

STOL Air Transport Systems

The purpose of this study is to report on the economic desirability of establishing an intercity STOL (Short Take-Off and Landing) air transport system in the Quebec-Windsor corridor. Such a system would be patterned along the lines of the Airtransit STOL Demonstration Service between Ottawa and Montreal, but would be developed around de Havilland's 50-seat DASH-7 aircraft, would operate from permanent STOLport facilities, and would serve several city pairs. Toronto Island Airport would serve as the terminus for STOL operations in Toronto. Montreal STOL operations could operate out of either Victoria Carpark, the site of the temporary STOLport used by the Airtransit Demonstration Service, or Dorval Airport. STOL operations would be based at existing conventional airport facilities in all other Central Canadian cities having STOL service to Toronto or Montreal.

STOL System Options

Two STOL System Options have been examined: The Two STOLport Option, with downtown STOLports constructed in both Montreal and Toronto (STOL would serve seven routes and seven Central Canadian cities) and the Single STOLport Option, which provides for a single downtown STOLport at Toronto Island (STOL would serve five routes and six Canadian cities, including a service between the Toronto Island STOLport and Dorval Airport).

Economic Evaluation of STOL Alternatives

The evaluation of the costs and benefits of STOL has been made in comparison with the modes which would likely be employed in the absence of STOL: transportation CTOL (Conventional Take-Off and Landing) aircraft, rail, bus and auto. Some attention has also been given to improved CTOL and rail modes.

The overall costs and benefits of a Canadian intercity STOL system may be expressed as three basic resource costs and three principal types of benefits. The resource costs are:

- infrastructure costs, which include land acquisition for STOLports, construction of STOLports and access to STOLports, on-going STOLport operations, grants paid to municipalities in lieu of taxes, and opportunity costs of publicly-owned land used for STOLports;

- increased transportation costs, which equal the differences in the values of the transportation resources which would be utilized, for ground transportation at the points of origin and destination, and for the intercity components of trips, with and without STOL; and

- $10 million in increased construction costs, which would be incurred by Hydro Quebec, due to costly re-routings of three planned power lines to the north and east of Victoria Carpark (the downtown Montreal STOLport site), which would be necessary to conform with STOL operations at that site (applicable to the Two STOLport Option only).

The three principal benefits are:

- trip-time savings realized by STOL users, taking into account time spent travelling to and from common carrier terminals, time spent in terminals before departure and after arrival, and time spent travelling between terminals;

- impacts on conventional airports, which would apply particularly to Malton and Dorval Airports, and which would take the form of reduced delays and congestion (during the 1980-1990 time period), and possibly some delay in the need for new facilities; and

- increased DASH-7 sales to the domestic carriers who would operate the STOL system in the Quebec-Windsor corridor, and to foreign carriers who would be swayed to purchase the aircraft, for both conventional and intercity STOL applications, by Canada's confidence in the aircraft and by the demonstrated success of the intercity STOL system concept.

There are also certain other less significant economic costs and benefits which are discussed in the report.

Evaluation of Economic Costs

A summary of the principal economic costs associated with the two STOL system options, on a present value basis, in total and per passenger, is contained on Table A.[1]

Table A

Principal Economic Costs of STOL System Options
(Present value in $1976, for the period 1976-90)

	Two STOLport Option		Single STOLport Option	
	Total Cost	Per STOL Passenger	Total Cost	Per STOL Passenger
Infrastructure costs	$91M	$9.80-16.60	$58M	$8.90-14.70
Increased transportation costs	59M-100M	10.70	43M-72M	11.00
Increased Cost of Hydro Quebec project	10M	1.10-1.80	-	-
Total economic cost	$160M-201M	$21.60-29.10	$101M-130M	$19.90-25.70

As indicated in Table A, the present value of the overall increase in total resource costs over the period 1976-1990 would be expected to fall between $160 and $201 million for the Two STOLport Option, and between $101 and $130 million for the Single STOLport Option, depending upon the level of STOL passenger volumes actually realized. On a per STOL passenger basis, total economic cost would be between $21.60 and $29.10 for the Two STOLport Option, and between $19.90 and $25.70 for the Single STOLport Option.

---

1 The ranges given in Tables A, B and C for "total costs", "total benefits" and total costs and benefits "per STOL passenger" reflect uncertainty over the levels of STOL passenger volumes that would actually be realized.

Evaluation of Economic Benefits

The principal STOL benefits include trip-time savings for STOL users, cost savings associated with a possible delay in the construction of new terminal facilities in the Toronto area in the mid-1980s, a reduction in delays and congestion at Malton Airport, and to a lesser extent, at Dorval Airport, and the positive effect the system could have on the Canadian aerospace industry, by generating additional DASH-7 sales.

A summary of estimated average one-way "door to door" trip-time savings, over all STOL routes, is contained in Table B. Thus, it is expected that for the "Two STOLport Option", the average STOL passenger would experience an average one-way trip-time saving of 39 minutes, with those diverted from CTOL (79% of all STOL passengers) saving an average of only 15 minutes. For the Single STOLport Option, average time savings would be predictably less -- 22 minutes for all STOL passengers and only 2 minutes for those diverted from CTOL (86% of all STOL passengers).

Table B

One-Way Average Trip Time Savings (Minutes)

	Two STOLport Option	Single STOLport Option
All STOL passengers	39	22
Former CTOL passengers only	15	2

For the purpose of analysis, travel-time savings have been valued at $19.50 per hour for all STOL passengers on the shorter routes and for all STOL passengers diverted from CTOL on all other routes, and at $11 per hour for all STOL passengers diverted from rail, bus, and auto on the longer routes.

It was estimated that, as a result of the introduction of STOL services in the Corridor, the need for a major new airport in the Toronto area would be delayed by only two to four months, depending on the volume of STOL traffic diverted from Malton to Toronto Island. The estimated economic benefit associated with the delay in constructing a new airport is shown in Table C.

The impact of STOL on delays and congestion at Malton and Dorval Airports would be greatest at Malton, where significant delays and congestion will be experienced in the early 1980s. STOL's main contribution would be to reduce peak-hour demand fcr runway use during periods when wind conditions restrict operations to a single runway. A runway delay analysis has shown these benefits to be quite small, however, with total time-savings to CTOL passengers being equivalent to an average time-saving of less than 4 minutes per <u>STOL passenger</u>. Other benefits related to STOL's effects on congestion levels at conventional airport facilities would be of even less significance. In particular, a reduction in the frequency of short-haul domestic Air Canada flights would only provide minor relief to the terminal congestion problem at Malton, would result in only slight reductions in noise levels at both Malton and Dorval, and would permit, at most, very modest savings from a postponement of the construction of additional airport terminal facilities at Mirabel Airport.

It has been estimated that over the entire 1980-1990 period the value of the benefits described in the preceding paragraph would not exceed $0.50 per STOL passenger for the Two STOLport Option and $0.25 per STOL passenger for the Single STOLport Option.

The expected present value of the "industrial benefits" has been estimated to be $42M, for both the Two STOLport and Single STOLport Options. This figure, which is highly tentative, corresponds to an expected number of "induced" DASH-7 sales of 89 (52 to foreign air carriers and 37 to domestic carriers) and an average net economic benefit of $472,000 per DASH-7 sale.

Estimates of the three principal benefits, on a present value basis, in total and per STOL passenger, are contained in Table C.

Table C

Principal Economic Benefits of STOL System Options
(Present value in $1976, for the period 1976-1990)

	Two STOLport Option		Single STOLport Option	
	Total Benefit	Per STOL Passenger	Total Benefit	Per STOL Passenger
Travel time savings	$53M-91M	$9.70	$19M-31M	$4.85
Benefit to CTOL airports -Delay in new Toronto airport	8M-13M	1.40	7M-11M	1.80
-Reduced congestion	3M-5M	.50	1M-2M	.25
Industrial benefits	42M	4.50-7.70	42M	6.50-10.60
Total economic benefit	$106M-151M	$16.10-19.30	$69M-86M	$13.40-17.50

Summary of Total Economic Costs and Benefits

Estimates of the total economic costs (from Table A) and benefits (from Table C), for the two STOL system options, expressed in present value terms, are contained in Table D. The total economic costs are expected to exceed total economic benefits by $50M-$54M for the Two STOLport Option and by $32M-$44M for the Single STOLport Option. On a per STOL passenger basis, total costs are expected to exceed total benefits by $5.50-$9.80 for the Two STOLport Option and by $6.50-$8.20 for the Single STOLport Option.

Table D

Overall Comparison of Principal Economic Costs and Benefits
(Present Value, in millions of $1976)

	Two STOLport Option		Single STOLport Option	
	Total Cost	Per STOL Passenger	Total Cost	Per STOL Passenger
Total economic cost	$160M-201M	$21.60-29.10	$101M-130M	$19.90-25.70
Total economic benefit	106M-151M	16.10-19.30	69M-86M	13.40-17.50
Total economic cost net of benefits	$50M-54M	$5.50-9.80	$32M-44M	$6.50-8.20

A sensitivity analysis was performed in order to estimate the statistical variation in the difference between total economic costs and benefits, due to errors in estimating each of the principal economic costs and benefits. It was concluded that for the Two STOLport Option, total costs would exceed total benefits with a probability in the range of 82% - 90%; for the single STOLport Option, total costs would exceed total benefits with a probability in the range of 83% - 87%.

Total costs net of benefits were found to be relatively insensitive to the social discount rate employed.

Conclusions of Economic Evaluation

The cost-benefit study concludes that, for both options considered, it is probable that total economic costs exceed total economic benefits. This means that, barring major errors in the estimation of costs and benefits, a STOL system in the Quebec-Windsor corridor cannot be supported on economic grounds, when it is compared with the base case alternative: namely, the continuation of service by existing transportation modes in the Corridor and development of the Toronto Island Airport site for market-oriented housing. Of the two STOL system alternatives considered, the Single STOLport Option was found to have the smaller net economic disbenefit.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

SECTION 1

STOL AIR TRANSPORT SYSTEMS

1. STOL AIR TRANSPORT SYSTEMS

Scope of Study

The purpose of this study is to report on the economic implications of establishing an intercity STOL (Short Take-Off and Landing) air transport system in the Quebec-Windsor corridor. Such a system would be patterned along the lines of the Airtransit STOL Demonstration Service between Ottawa and Montreal (which employed de Havilland Twin Otter aircraft), but would be developed around de Havilland's 50-seat DASH-7 STOL aircraft[1] and would serve several city pairs. In Toronto, a permanent STOLport would be constructed at Toronto Island Airport. Montreal STOL operations would operate out of either a permanent STOLport constructed at Victoria Carpark, the site of the temporary STOLport used in the Airtransit Demonstration Service, or out of Dorval Airport. STOL operations would be based at existing conventional airport facilities in all other Canadian cities likely to get STOL services to and from Toronto and/or Montreal (the largest being Quebec City, Ottawa, London, Windsor and Sudbury).

---

[1] There are currently no announced plans by any aircraft manufacturer for the development of a second generation jet-STOL aircraft capable of operating on 2,000-3,000 foot runways and having noise levels sufficiently low to permit use at proposed downtown STOLport facilities in Montreal and/or Toronto. Further, officials of Boeing Aircraft have indicated that such a development is not expected before 1985 at the very earliest. Consequently, it has been assumed that for high density intercity applications in Canada, the DASH-7 would serve as the principal STOL aircraft throughout the 1980-1990 planning period.

Although cases could possibly be made for the use of STOL on other high density routes, such as Edmonton-Calgary or Vancouver-Victoria, or as part of regional "feeder" systems, in areas where mountainous terrain prohibits the use of conventional aircraft, or in low density operations as an alternative to runway extension programs, these potential applications have not been examined in this report, as they may reasonably be addressed as separate issues, essentially unrelated to the question of whether an intercity STOL system should be developed in the Quebec-Windsor corridor. This report is strictly confined to an analysis of the use of DASH-7 aircraft on high-density intercity routes in the Quebec-Windsor corridor having "downtown STOLports" at one or both of the trip ends. Thus, no inference should be drawn from findings of this study as to the desirability of using STOL-type aircraft in any application other than the specific one addressed in this study.

Neither does this study attempt to evaluate non-economic factors which may bear on the decision of whether to develop an intercity STOL system in the Quebec-Windsor corridor. Such factors might include potential for recovering STOLport capital and operating costs, environmental considerations, implications for the Canadian aerospace industry and for Canadian air carriers, and policies, objectives and plans of other levels of government.

Economic Evaluation

The evaluation of the costs and benefits of STOL has been made in comparison with the modes which would likely be employed in the absence of STOL: CTOL (Conventional Take-Off and Landing) aircraft, rail, bus and auto.

The principal economic cost of the STOL system is the additional cost of transporting STOL passengers over what it would cost to transport them by the modes which they would select if STOL were not available. These costs include both infrastructure and carrier costs, and apply to both the access/egress and intercity portions of trips. The total transportation-related benefit represents the value of the resources which would be saved as a result of having STOL (especially the value of time saved by STOL passengers). In addition, the development of an intercity STOL system in Canada might result in increased DASH-7 sales to foreign carriers. The difference between the return on the marginal investment required to produce the additional DASH-7 aircraft and the return that the same resources could produce in other sectors of the economy represents an economic benefit (or cost, if the difference were negative) which should also be attributed to the development of the STOL system in the Corridor.[1]

---

1 For a discussion of cost-benefit analysis methodology, the reader is referred to Benefit - Cost Analysis Guide, Planning Branch, Treasury Board Secretariat, March, 1976.

STOL Passenger Characteristics

Before proceeding with an examination of the possibilities for intercity STOL services in the Quebec-Windsor corridor, it is perhaps useful to describe in general terms who the STOL passengers would likely be. One may assume with some confidence that they would not differ significantly from Airtransit's passengers in terms of occupational category, purpose and frequency of travel, and reasons for choosing STOL. From several passenger surveys taken during the Demonstration Service the following characterization has emerged. Airtransit passengers:

- travelled frequently (averaging 18 round trips per year between Montreal and Ottawa);
- travelled mostly on business (over 90%);
- had high incomes (average income was approximately $30,000 per year; 20% had incomes over $40,000 per year);
- placed a high premium on time savings, on-time performance and convenience in choosing between intercity modes;
- were not very concerned about comfort, amenities, or fare.[1]

The relative importance of each intercity mode as a source of STOL passengers depends upon trip length. Between Montreal and Ottawa - a fairly short route - Airtransit passengers indicated that if the Demonstration Service were not in operation they would have taken, in order of popularity: conventional aircraft (36%); automobile (28%); train (22%); and bus (10%). Only 4% said they would not have taken the trip at all. On longer routes, such as Toronto-Montreal and Toronto-Ottawa, it is expected that over 90% of the STOL passengers would be diverted from CTOL.

---

[1] Comfort and amenities may be of greater importance on longer routes, such as the 1 1/2-hour STOL flight between Montreal and Toronto.

STCL System Options

If an intercity STOL system is to be developed in the Quebec-Windsor corridor, it is essential that Toronto operations be based at Toronto Island Airport - no other potential STOLport site has been identified which would be technically feasible and more conveniently located than Malton Airport.[1]

In Montreal, Victoria Carpark is the only downtown site which has been identified as a possible location for a STOLport.[2] Victoria Carpark is ideally located, but would

---

[1] Downsview has been ruled out because of air traffic control considerations (ref. Report #121, Aviation Systems Planning Branch, Toronto Area Airports Project, Transport Canada, April 15, 1976).

[2] Two other possible STOLport sites in Montreal have been examined and rejected. The existing St. Hubert Airport, located approximately 10 miles east of Dominion Square, would be much less expensive to develop than Victoria Carpark ($13M vs. $36M), but would be very poorly located for STOL services. For the large majority of STOL passengers, ground access times to St. Hubert Airport would be greater than those to Dorval, where STOL facilities could be provided at very little cost. Consequently, St. Hubert has been judged inferior to Dorval as the Montreal terminus for STOL operations. The only other location for a STOLport in Montreal would be a vacant property in LaSalle, approximately five miles southwest of Dominion Square. Although the cost of facilities (including land acquisition) is estimated to be approximately $15M less for the LaSalle site than for Victoria Carpark, the LaSalle site suffers from several serious drawbacks. First, although the LaSalle site would be a better location for a STOLport than St. Hubert, it is still not nearly as attractive a location as Victoria Carpark (driving time from Dominion Square to Victoria Carpark is approximately 5 minutes; to the LaSalle site it would be at least 15 minutes). Secondly, because of the close proximity of the LaSalle site to Dorval Airport, and because of constraints on the possible orientation of the STOLport's runway, there would be extensive intermixing of CTOL and STOL aircraft in the airspace immediately surrounding Dorval Airport which would result in lengthy delays for aircraft using both airports. Finally, strong objections to the development of a STOLport at the LaSalle site could be expected from residents of Montreal-West, some of whom would live as close as one-half mile from the end of the runway.

(continued on next page)

be expensive to develop as a permanent STOLport. (The site is a former garbage dump and could therefore require a costly excavation and fill operation.) An alternative to the Victoria Carpark site would be to base Montreal STOL operations at Dorval Airport. The attraction of this alternative is that $36M in construction costs for the Victoria Carpark STOLport would be avoided. The disadvantage of this alternative is that STOL services from Montreal would be limited to the Dorval-Toronto Island route,[1] where there would be no total trip time advantage over conventional air services operating between Dorval and Malton Airports.

Forecast traffic volumes and potential travel time savings would not at present justify the construction of downtown STOLport facilities in any central Canadian city other than Toronto or Montreal.[2] Consequently, in all other cities having STOL services to Toronto and/or Montreal, STOL operations would be based at existing conventional airports (e.g., Quebec City, Ottawa, London, Windsor, and Sudbury).

---

2 (continued from previous page)
For these reasons, the LaSalle site is viewed as less desirable than either Victoria Carpark or Dorval Airport.

1 It is believed that STOL could not compete, time-wise or cost-wise, with jet services if both were operating between Dorval Airport and conventional airports in either Ottawa or Quebec City.

2 In Ottawa, Rockcliffe Airport could possibly be used instead of Ottawa International, but this is not an important consideration, as the location of Rockcliffe Airport would be at best marginally more convenient for STOL passengers than Ottawa International (due to the expected large proportion of trips beginning and/or ending at home).

It follows from the above considerations that the federal government is faced with three basic policy choices:

- Two STOLport Option: Under this option the government would give approval and financial support for the development of permanent STOLport facilities at both Toronto Island and Victoria Carpark, to enable one or more commercial air carriers to operate an intercity STOL air transport service in the Quebec-Windsor corridor using DASH-7 aircraft[1].

- Single STOLport Option: This option differs from the Two STOLport Option in that only one downtown STOLport would be constructed, at Toronto Island, and Montreal STOL operations would be based at Dorval Airport.

- The final option is not to develop an intercity STOL system in the Quebec-Windsor corridor.

---

1 There are no other aircraft of the size of the DASH-7, or larger, that could operate from the downtown Montreal STOLport. The DASH-7 is not the only aircraft of its size that could operate from the Toronto STOLport, but it would be the quietest, and could operate at lower weather minimums than any other aircraft in its class, or larger. In addition to DASH-7 operations, 19-seat de Havilland Twin Otter aircraft could be used to connect certain smaller centres with Toronto Island, but this would not be an important consideration, because of the relatively small number of additional passengers involved. Victoria Carpark would be limited to DASH-7 operations. To construct the facility to allow for Twin Otter operations as well would increase capital costs by an estimated $26M which probably could not be justified by the limited additional air services that would be permitted.

The option of building a downtown STOLport only in Montreal (at Victoria Carpark), and providing STOL services between Montreal and conventional airports in Toronto, Ottawa and Quebec City, has been considered, but discarded, as it was found to be clearly inferior to the Single STOLport Option described above.[1]

Non-STOL Transportation Alternatives

Other intercity transportation alternatives to STOL have also been examined, though not in great detail. The principal transportation alternatives to STOL (not including the status quo) are two: improved rail service and the transfer of some short-haul air services to a specialized short-haul conventional air carrier (i.e., to a local or regional airline).

Improved Rail Service

Improved rail service in the Corridor would likely take the form of improvements to existing speed-related rail infrastructure and the greater use of Turbo or LRC (light, rapid and comfortable) trains. It would be technically feasible to construct new high-speed rail lines on dedicated tracks that would permit use of equipment capable of maximum speeds up to 250 Kilometres per hour, but the capital infrastructure cost alone would be extremely high, possibly more than one billion dollars for the Montreal-Toronto route alone. In view of the heavy infrastructure and equipment costs required for such a high-speed rail system, and the limited potential traffic volumes (compared with numbers of passengers carried by high speed, intercity passenger rail systems in Japan, England and France), it seems unlikely that this type of high-speed intercity passenger rail service will be established in the Quebec-Windsor corridor in the foreseeable future.

---

[1] Total economic costs, expressed as an average cost per STOL passenger, were found to be slightly higher for this option than for the Single STOLport Option. Travel time savings per STOL passenger are approximately the same for the two options. The most significant difference between the two options is the impact they would have on conventional CTOL airports. Whereas the Single STOLport Option would, by diverting some short haul traffic from Malton Airport, result in some reduction in delays and congestion there, the option considered above would result in an increase in the number of aircraft movements at Malton, and thereby would aggravate the congestion problem there.

With the exception of the Montreal-Toronto route, substantial improvements in passenger rail services could be made on most Corridor routes for relatively small expenditures. The existing Montreal-Toronto service now has relatively good frequency (seven trains daily, each way) and fast trip times (four hours, ten minutes, for the twice-daily Turbos). Improvements on this route would be extremely costly and less cost-effective than improvements on the other Corridor route segments.[1]

Table 1 gives estimates of station-to-station and average door-to-door trip times on those Corridor routes for which speed-related rail infrastructure improvements may be considered, for CTOL, STOL, existing passenger rail and improved passenger rail.[2] The estimated costs of the rail infrastructure improvements (not including any public crossings that may be required with the higher operating speeds) are $24 million for the Quebec-Montreal route, $5-$10 million for the (CP South Shore) Montreal-Ottawa route, $5-$10 million for the Toronto-Ottawa route[3], and $15 million for the Toronto-London-Windsor route.

Table 1 Station-to-Station and Average Door-to-Door Travel Times by Mode, for Selected Corridor Routes (in minutes)

	Station-to-Station Travel Time				Average Door-to-Door Travel Time			
Route	CTOL	STOL	Existing Rail[1]	Improved Rail[1]	CTOL	STOL	Existing Rail[1]	Improved Rail[1]
Montreal-Quebec	40	50	180	150	122	111	237	207
Montreal-Ottawa	30	40	120	95	126	115	185	160
Toronto-Ottawa	53	68	335	270	151	143	400	335
Toronto-London	35	38	120	95	119	99	177	152
Toronto-Windsor	45	61	235	180	129	122	292	237

1 Rail travel times correspond to fastest existing or proposed service.

1 It has been estimated that an investment of $200 million in infrastructure on the Montreal-Toronto route would only reduce trip times with the Turbo service by 10-20 minutes.

2 See Appendix D, Section 1 for a description of travel time estimates by mode.

3 For an additional expenditure of $40-$70 million, station-to-station travel time on the Toronto-Ottawa route could be reduced a further 60 minutes, to 210 minutes.

It would appear from the door-to-door travel time estimates in Table 1 that STOL and improved rail might compete for much of the same travel market on the Montreal-Ottawa and Toronto-London routes. Limited competition might exist between STOL and improved rail on the Montreal-Quebec and Toronto-London routes, but in both cases, (one-way) door-to-door travel times would be more than one and one half hours less with STOL than with improved rail. Considering also the relatively small differences in estimated door-to-door travel time between STOL and CTOL on these two routes (11 minutes and 7 minutes, respectively), it would seem unlikely that the introduction of STOL on those routes would substantially affect the volume of improved passenger rail traffic. Very little competition would be expected between STOL and improved rail on the two longest routes - Toronto-Montreal and Toronto-Ottawa - in view of the very large door-to-door time savings of STOL over improved rail, and the comparatively small difference in door-to-door travel time between STOL and CTOL.

Thus, with the exception of the Montreal-Ottawa and Toronto-London routes, it seems likely that improved rail service would generally serve a different market than STOL. Since these two routes would together only account for approximately 8%-17% of the total, system-wide STOL traffic volume, it has been concluded that proposed Corridor STOL and improved rail services can reasonably be analyzed as separate issues - that is, that the adoption of either transportation system would not significantly influence the desirability of adopting the other as well.

Specialized Short-Haul Conventional Air Carrier

It has been suggested that as an alternative to STOL, consideration should be given to allowing local or regional carriers greater access to high-volume short-haul routes. Such a specialized short-haul service would have two possible benefits over existing air service in the Montreal-Windsor corridor, which is now provided almost exclusively by Air Canada: a specialized short-haul service might be able to process passengers more efficiently and might be less expensive to operate.

Because both Air Canada and a specialized short-haul carrier would use basically the same equipment and would share common airport facilities, it is not readily apparent how lower terminal occupancy times could be achieved by a specialized carrier. A specialized carrier could not effectively limit traffic to origin/destination, or non-connecting passengers, especially on the less dense routes. Hence, baggage processing facilities and baggage transfer procedures would still be necessary for servicing connecting passengers. Recognizing also that passengers connecting to Air Canada flights at Malton, Dorval or Mirabel would experience greater inconvenience by travelling with a specialized short-haul carrier, it would appear that a specialized short-haul carrier would have no particular advantage over Air Canada in terms of the level of service and convenience which it could provide.

With regard to the question of possible cost savings, the relevant question is whether the costs incurred by the specialized carrier would be exceeded by the costs avoided by Air Canada. This is a difficult question and one which even Air Canada would be hard-pressed to answer. In view of the fact that a large portion of the costs would be the same for both carriers (cost of aircraft, fuel, parts, insurance, etc.) it would appear that on a per passenger basis, the cost differential could not be too large. The expense for which the cost differential is greatest would probably be flight crew costs.

On the basis of current wage contracts, for comparable short-haul jet aircraft and years of service, crew costs per hour at regional air carrier wage rates appear to be approximately 23% lower than at Air Canada rates.[1] However, this differential only amounts to about $0.35 per passenger on the Montreal-Toronto route, and even less on shorter routes. On the other hand, it is questionable whether Air Canada would be able to avoid as much administrative overhead and capital expenditure on buildings and maintenance equipment as a specialized air carrier would incur.

In sum, it is unclear whether overall efficiencies would result and it is unlikely that the issue can be resolved without a major in-depth study of air carrier operations and costs. However, any potential improvements in overall operating efficiencies would probably be marginal at best. Thus, the desirability of an intercity STOL system should be not influenced greatly (i.e., in comparison with other costs and benefits) by the form of the conventional short-haul air service assumed as a basis for comparison, whether it be as it is now structured or involve an expanded role for the local or regional air carriers. For purposes of analysis it has been assumed that Air Canada will retain its present dominant role in the Quebec-Windsor corridor.

---

[1] It appears that this differential in crew cost now exists because of institutional reasons, and does not necessarily reflect differentials in productivity and/or safety standards. Moreover, it is not certain that this differential would persist if regional airlines were permitted to grow significantly in size.

SECTION 2

EVALUATION OF STOL SYSTEM OPTIONS

2. EVALUATION OF STOL OPTIONS

Economic Costs and Benefits

The development of an intercity STOL service would require the use of certain scarce resources, but would also free other resources now employed. In particular, the initial provision and continuing maintenance of the STOL infrastructure would require major capital and on-going expenditures. Similarly, considerable resources would be required for the operation of a STOL air carrier. On the other hand, a diversion of traffic to STOL from other intercity transportation modes (CTOL, rail, bus, auto) would allow for some reduction in the employment of resources by those modes. Further, STOL would produce travel time savings, and a diversion of traffic from CTOL to STOL could allow for a postponement in the construction of major new airport facilities in the Toronto area and would also result in some reduction in delays, congestion and possibly noise at CTOL airports (as compared to levels which would prevail in the absence of STOL). The establishment of an intercity STOL system in Canada might also have a positive effect on foreign DASH-7 sales, which could in turn generate economic benefits.

Although it is difficult to assess a dollar value for all of the economic costs and benefits associated with STOL, it is useful to quantify them to the greatest extent practicable so that at least a partial aggregation of effects is possible. In this way, one may keep to a minimum the number of basic factors which must be considered and weighed simultaneously when deciding the basic issue: should an intercity STOL system be established in the Quebec-Windsor corridor?

The overall costs and benefits of a Canadian intercity STOL system may be expressed as three basic resource costs and three principal types of benefits. The resource costs are:

- infrastructure costs, which include land acquisition for STOLports, construction of STOLports and access to STOLports, on-going STOLport operations, grants paid to municipalities in lieu of taxes, and opportunity costs of publicly-owned land used for STOLports;[1]

---

1 The Toronto and Montreal STOLport sites are both publicly owned. If one or both were privately owned, the fair market value of the land would be used as the cost of the sites.

- <u>increased transportation costs</u>, which equal the differences in the values of the transportation resources which would be utilized, for ground transportation at the points of origin and destination, and for the intercity components of trips, with and without STOL;[1] and

- <u>$10M in increased construction costs</u> which would be incurred by Hydro Quebec, due to costly re-routings of three planned power lines to the north and east of Victoria Carpark (the downtown Montreal STOLport site), which would be necessary to conform with STOL operations at that site (applicable to the Two STOLport Option only).

The three principal benefits are:

- <u>trip time savings</u> realized by STOL users, taking into account time spent travelling to and from common carrier terminals, time spent in terminals before departure and after arrival, and time spent travelling between terminals;[2]

- <u>impacts on conventional airports</u>, which would apply particularly to Malton and Dorval Airports, and which would take the form of reduced delays and congestion (during the 1980-1990 time period), and possibly some delay in the need for new facilities; and

---

[1] As defined, transportation costs could be positive or negative, depending upon whether the total value of transportation resources employed would be greater with STOL or without STOL.

[2] On the basis of information gained through the STOL Demonstration Project, it is not expected that STOL would increase total intercity travel to any significant degree. Consequently, no benefits have been assessed for "improved communications", as is sometimes appropriate when air services are first provided to small communities.

- increased DASH-7 sales to the domestic carriers who would operate the STOL system in the Quebec-Windsor corridor, and to foreign carriers who would be swayed to purchase the aircraft, for both conventional and intercity STOL applications, by Canada's confidence in the aircraft and by the demonstrated success of the intercity STOL system concept.

In addition to these principal costs and benefits, there are several secondary considerations which are discussed in the Appendices. Included among the secondary economic costs:

- height restrictions imposed on future urban development in the eastern part of the City of Verdun, to the west of the Montreal STOLport site (Appendix B, Section 1); and

- landing delays for some CTOL flights at most conventional airports used also for STOL operations (Ottawa, Quebec City, and London Airports; and for the Single STOLport Option, Dorval International Airport) (Appendix D, Section 1).

The secondary STOL benefits discussed in the Appendices include the following:

- for an additional expenditure of approximately $2.1 million, general aviation (GA) facilities could be provided at the Toronto Island STOLport, an option not available if the site were used for some non-aviation purpose (Appendix B, Section 1);

- total transportation-related net energy savings of approximately one and one-half gallons of fuel per STOL passenger (for an average fuel savings of 11%-14% per STOL passenger), which would amount to annual fuel savings of between one and two million gallons of fuel (Appendix D, Section 4); and

- increased frequency of combined STOL and CTOL air service, offset by a reduced level of service to connecting CTOL passengers.

Principal Economic Costs

A snapshot of the two STOL system options under consideration is contained in Table 2. These options have been described in general terms earlier and are developed in detail in Appendix A. Observe that for both options, roughly one-half of the total passenger volume would be from the Montreal-Toronto route, and over 75% of all traffic would be in the Montreal-Toronto-Ottawa triangle. The low and high passenger volumes given are respectively "pessimistic" and "optimistic" forecasts.

The infrastructure costs for each of the two STOLports are summarized in Table 3.[1] (A detailed treatment of STOLport costs can be found in Appendix B.) The construction costs are greater for the Montreal STOLport because of an extensive excavation and fill operation that probably would be required to provide a stable footing for the runway, taxiway, terminal and apron, and to overcome the safety problem created by the continuing release of methane gas. Annual costs at both STOLports include airport operation and maintenance, telecommunications and traffic services, and grants to municipalities in lieu of taxes.[2]

---

[1] As costed in Table 3, the Montreal site would provide for DASH-7 operations only; to make it also suitable for Twin Otter use (to provide service on low density routes such as Montreal-Sherbrooke), total capital costs would increase by $26 million. (See Appendix B).

[2] These grants are assumed to approximate the costs incurred by the surrounding municipalities in providing and maintaining services which would result, directly or indirectly, from the construction and operation of the STOLports.

Table 2 Specification of STOL System Options

	Two STOLport Option	Single STOLport Option
Downtown STOLports	Montreal (Victoria Carpark) Toronto (Toronto Island)	Toronto (Toronto Island)
Routes Served by STOL (% total STOL traffic volume)	Montreal-Toronto (50%) Montreal-Ottawa (13%) Montreal-Quebec (6%) Toronto-Ottawa (16%) Toronto-London (5%) Toronto-Windsor (4%) Toronto-Sudbury (6%)	Toronto-Dorval (61%) Toronto-Ottawa (19%) Toronto-London (7%) Toronto-Windsor (5%) Toronto-Sudbury (8%)
Total Forecast One-Way STOL Passenger Volumes (millions)[1]		
1980		
low	1.0	0.7
high	1.7	1.2
1985		
low	1.3	0.9
high	2.2	1.5
1990		
low	1.7	1.2
high	2.8	2.0

[1] From Tables A5 and A6, Appendix A.

Table 3 STOLport Infrastructure Costs

($1976 in millions, 10% social discount rate)

	Montreal STOLport	Toronto STOLport	Two STOLport Option	Single STOLport Option
STOLport Construction Costs[1]	36M	22M	58M	22M
Annual Costs	1.6	2.9	4.5	2.9
Present Value Total Cash Costs[2]	33	28	61	28
Economic Cost of Using Publicly-owned Land (1977-1990)[3]	0	30	30	30
Present Value Total Economic Costs	33	58	91	58

[1] Assumes salvage value in 1990 is zero.

[2] Present value of all cash costs between 1977 and 1990, discounted at 10% to 1976.

[3] Equals present value of annual rents between 1977 and 1990, assuming values of Montreal and Toronto sites are $0.3 million and $40 million, respectively, and rent is 10% of market value annually.

In its present state, the Montreal STOLport site is estimated to have a value of only $300,000.[1] By contrast, the Toronto Island site is extremely valuable for housing and/or recreational development, having an estimated economic value of $40,000,000.[2] A portion of the site owned by the City of Toronto has been leased to the Toronto Harbour Commission (which owns most of the site) for use as an airport.

For the purpose of estimating the value of the resources which would be required for the development of a STOL system, it does not matter whether the STOLport sites are currently owned by the federal government, are leased to the federal government for nominal amounts, or would have to be purchased by the federal government at full market value. This is not to say that such considerations are not important from a budgetary point of view; merely that the current ownership of the land is irrelevant to the determination of the value of the resource, which by definition is the opportunity cost associated with the alternative land use having the greatest economic value.

---

1 Three acres valued at $100,000 per acre would have to be acquired from CNR. For any commercial development, the remaining 91 acres would likely have to be excavated and filled at an average cost of $10/sq.ft. As its subsequent market value would be only $2.25/sq.ft., the 91-acre portion can be assumed to have no value in its present condition.

2 In the case of the Toronto Island site, it is <u>assumed</u> that the alternative land use having the greatest economic value would be a medium density housing development. Under this assumption, the value of the land is calculated to be approximately $40M (in January, 1976 dollars), which is the present value (of the market value) of the housing units minus the present value of all costs associated with the development of the site, including the provision of access. This figure of $40M represents a <u>lower bound</u> on the value of the land, for if some other type of development (such as recreation, low income housing, continued exclusive use of general aviation, etc.) were regarded as a <u>more</u> desirable use of the land, then the value of this land would, <u>ipso facto</u>, be greater than $40M. However, as there are no apparent markets for valuing the benefits associated with these other kinds of development, there is no means available for estimating a value for the land under alternative use assumptions.

A 10% real social discount rate has been selected for use in this study. This is the figure currently recommended by the Treasury Board Secretariat in their Benefit-Cost Guide (1976). An empirical basis for this particular level has been provided in a study by Glenn Jenkins, in which he computes the average real gross return on capital in the private sector, weighted by industry to reflect the relative flows of capital funds displaced by the federal government, over the period between 1965 and 1969.[1,2] Jenkins concludes that:

> "Whenever the Canadian governments engage in projects whose net social benefits fail to yield a positive net present value when discounted at the social opportunity cost of public funds, approximately 9.5%, the economy as a whole would be better off without the projects."[3]

To determine the sensitivity of the costs and benefits to the social discount rate employed, calculations have also been made using real social discount rates of 5% and 15%, as recommended in the Benefit-Cost Guide. The results for the 5% and 15% rates are reported at the end of this Section.

---

1 Glenn P. Jenkins, Analysis of Rates of Return from Capital in Canada, unpublished Ph.D. dissertation, University of Chicago, December, 1972.

2 Observe that for an 8% rate of inflation and an average corporate tax rate of 50%, a 10% gross real return is equivalent to an after-tax nominal private rate of return of 9.4%.

3 Jenkins, op. cit., p. 99.

Summaries of the principal costs associated with the two STOL system options, in total and on a per passenger basis[1], are contained in Tables 4 and 5. The transportation costs consist of both the access/egress (to and from terminals) costs and intercity costs. The intercity resource costs reflect the costs per passenger of operating a STOL service minus a weighted average of the total costs (capital plus operating) which would be avoided by other competing modes (CTOL, rail, bus and auto) as a result of traffic being diverted to STOL. The access/egress cost savings associated with STOL reflect a weighted average of cost differences between STOL and each of the four existing modes, averaged over all routes served by STOL. A detailed derivation of these cost differentials is contained in Appendix C (intercity costs) and Appendix D, Section 2 (access/egress costs).

---

1 The total economic costs "per STOL passenger" are measures of the present value of all resource costs "averaged" over all STOL passengers. They are calculated in such a way that when multiplied by the number of STOL passengers in each year between 1980 and 1990, the 11 products, discounted to 1976 (at 10%), sum to the present value of the total costs. Alternatively, the "per STOL passenger" cost may be interpreted as the value of the economic benefit which would have to be realized by each STOL passenger between 1980 and 1990 in order for the present value of all such benefits (discounted to 1976) to equal the present value of all economic costs.

Table 4 Present Values of Total Economic Costs[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Infrastructure costs[2]	91M	91M	58M	58M
Increased transportation costs[3]	100M	59M	72M	43M
Increased cost of Hydro Québec project	10M	10M	-	-
Total increased costs	201M	160M	130M	101M

Table 5 Present Values of Total Economic Costs per STOL Passenger[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Infrastructure costs[4] per STOL passenger	9.80	16.60	8.90	14.70
Increased transportation costs[5] per STOL passenger	10.70	10.70	11.00	11.00
Increased cost of Hydro Quebec project	1.10	1.80	-	-
Total Economic Costs per STOL Passenger	21.60	29.10	19.90	25.70

---

[1] Based on a 10% discount rate for 1980-1990 period.

[2] From Table 3.

[3] From Table C13 (Appendix C).

[4] From Table B8 (Appendix B).

[5] From Table C12 (Appendix C).

The estimated $10M in increased costs to Hydro Quebec was estimated by Hydro Quebec officials, working in close cooperation with Transport Canada officials.

As indicated in Table 4, the present value of total economic costs over the period 1976-1980 would be expected to fall between $160M and $201M for the Two STOLport Option, and between $101M and $130M for the Single STOLport Option, depending upon the level of STOL passenger volumes actually realized. On a per STOL passenger basis (Table 5), the expected increase in resource costs would be between $21.60 and $29.10 for the Two STOLport Option, and between $19.90 and $25.70 for the Single STOLport Option.

Principal Economic Benefits

The principal STOL benefits include the trip-time savings for STOL users, the reduction in delays and congestion at Malton Airport, and, to a lesser extent, at Dorval Airport, cost savings associated with the possible delay in the construction of new terminal facilities in the Toronto area and the positive effect the system could have on the Canadian aerospace industry, by generating additional DASH-7 sales.

Trip Time Savings

Because of the convenient locations of downtown STOLports in Toronto and (in the case of the Two STOLport Option) Montreal, and the fact that the business clientele being served would generally begin and/or end a trip downtown, STOL would result in an average access plus egress time savings (for one-way trip) over CTOL of 23 minutes for the Two STOLport Option and 15 minutes for the Single STOLport Option. Access/egress time savings for STOL over rail and bus would be negligible.

It is expected that STOL terminal times would be somewhat less than both CTOL and rail terminal times. STOL blocktimes (i.e., "terminal to terminal") would be greater than CTOL blocktimes -- especially for longer routes -- but would be less than those for the three surface modes.

A summary of the expected average one-way trip-time savings, weighted over all STOL routes, is contained in Table 6.[1] Thus, it is expected that for the Two STOLport Option, the average STOL passenger would experience an average one-way trip-time saving of 39 minutes, with those diverted from CTOL (76% of all STOL passengers) saving an average of only 15 minutes. For the Single STOLport Option, average time savings would be predictably less -- 22 minutes for all STOL passengers and only 2 minutes for those diverted from CTOL (86% of all STOL passengers)

Table 6 One-Way Average Trip-Time Savings (Minutes)

	Two STOLport Option	Single STOLport Option
All STOL passengers[2]	39	22
Former CTOL passengers only[3]	15	2

---

[1] The estimates of travel time savings are discussed in Section 1 of Appendix D.

[2] From Table D2 (Appendix D).

[3] From Table D3 (Appendix D).

Value of Time Savings

It has been determined from Airtransit surveys that the average household income of STOL passengers was about $30,000 per year. If we assume that these household incomes were earned entirely by Airtransit passengers, that STOL passengers each worked an average of 2,000 hours per year, and that fringe benefits amounted to 30% of gross income[1], then the average marginal cost of employing each STOL passenger was approximately $19.50 per hour. Assuming that this cost is an accurate estimate of productivity, that all travel time savings with STOL were used for productive purposes (as opposed to leisure purposes), and that productivity was virtually nil during periods of intercity travel, it follows that the average value of time saved by Airtransit passengers was approximately $19.50 per hour.

Several arguments have been suggested as to why this value of time savings may either be too low or too high. Reasons given for this value of time being too low are principally the following:

- the hourly figure should include a portion of the employing firms' overhead and profits; and

- the hourly figure should be applied to a quantum of time measures in portions of a day (e.g., one-half of a working day saved by STOL).

The rationale for the first argument is that the average productivity of STOL passengers would exceed their marginal cost to their employers, a proposition which is neither supported nor refuted on the basis of the available information.

---

1 This estimate for fringe benefits was suggested by officials in the Personnel Policy Branch of the Treasury Board Secretariat.

The rationale for the second argument is that the marginal time savings with STOL and/or the increased frequency of STOL over other modes would permit a "half-day business trip", or would allow the traveller to conduct enough business during one trip to "save another trip". While this may well be true to some extent on the Montreal-Ottawa route, it would probably not apply to the same degree for longer routes, such as Toronto-Montreal and Toronto-Ottawa, where round trip travel times with STOL would be approximately 4 3/4 hours (approximately 1 1/4 hours greater than the Airtransit Montreal-Ottawa round trip travel times). Further, the frequency of scheduled CTOL service is expected to be extremely good during the 1980-1990 planning period for most of the proposed STOL routes, as indicated in Table 7.[1] Hence, improved frequency of air service would not be expected to be a significant STOL benefit for most STOL passengers.

Those arguing that $19.50 per hour is <u>too high</u> as a value of time savings put forth two principal arguments:

- that a portion of travel time savings represents reduced leisure time, which should be valued at a lower rate; and

- that a portion of travel time is spent productively (reading, writing, or thinking).

There is little evidence to support or contest the validity of either of these arguments; however, the reader may wish to draw upon his or her own travel experience and observations in forming an opinion about their validity.[2]

---

1 The figures in Table 7 for numbers of CTOL flights are based upon extrapolations of current CTOL frequencies (in proportion to projected increases in CTOL local traffic, not of those CTOL passengers who would be diverted to STOL).

2 The first point no doubt applies on longer trips, such as those which begin on a Sunday or end late at night.

Table 7 Projected Numbers of STOL and CTOL Flights per Weekday, in 1985, by Route, Two STOLport Option[1]

	1976	1985			
		No STOL	With STOL		
	Current CTOL	CTOL	CTOL	STOL	CTOL + STOL
Montreal-Toronto	25	44	28-36	35-59	71-87
Montreal-Ottawa	19[2]	35	32-34	8-16	42-48
Montreal-Quebec	14	16	14-15	5-9	20-23
Toronto-Ottawa	20	30	23-26	12-20	38-43
Toronto-London	9	11	10-11	5-10	16-20
Toronto-Windsor	5	6	5-6	3-4	8-9
Toronto-Sudbury	4	13	10-11	5-8	16-18

The $19.50 per hour figure has been adopted here as the average value of time for all STOL passengers travelling on the Montreal-Ottawa route, and also the London-Toronto route, which is of similar length, as well as for all STOL passengers diverted from CTOL on all other routes. However, it would appear that $19.50 per hour would be a substantial overestimate of the value of time for STOL passengers diverted from rail, bus and auto modes on the longer STOL routes. For example, coach rail passengers now travelling between Montreal and Toronto could, by travelling CTOL instead, save approximately 3.4 hours of one-way total trip time at an additional personal one-way trip cost (including access/egress cost) of approximately $40. Hence, all other considerations being equal, we infer that the value of their time is not more than $11.75 per hour. Accordingly, the value of time for STOL passengers diverted from rail, bus and

---

1 Equals number of daily flights in each direction.

2 Assumed level if Airtransit had not been in operation (17 actual + 2 additional).

auto, on all routes other than Montreal-Ottawa and Toronto-London, is estimated to be $11.00 per hour.

An analysis of the time savings indicates that 54% and 73% of the total one-way trip time savings, for the Two STOLport and Single STOLport Options, respectively, would be realized by STOL passengers diverted from rail, bus and auto on routes other than Montreal-Ottawa and London-Toronto. Consequently, the average value of time for all STOL passengers is estimated to be $14.90 per hour ((.54)(11.00) + (.46)(19.50)) for the Two STOLport Option and $13.30 per hour ((.73)(11.00) + (.27)(19.50)) for the Single STOLport Option.

Applying these values of time to the two STOL system options yields an average value of time savings of $9.70 per STOL passenger for the Two STOLport Option (39 minutes @ $14.90 per hour) and $4.85 per STOL passenger for the Single STOLport Option (22 minutes @ $13.30 per hour). The average value of travel time savings for only those STOL passengers who would be diverted from CTOL is much less: $4.90 per passenger for the Two STOLport Option[1] (15 minutes @ $19.50 per hour) and $0.70 per passenger for the Single STOLport Option[2] (2 minutes @ $19.50 per hour). These estimates may of course be adjusted up or down depending upon whether the values of time adopted are regarded as too low or too high.

---

[1] 76% of STOL passengers would be diverted from CTOL; the remaining 24% (from all other modes) would realize a time savings having an average value of $24.30.

[2] 86% of STOL passengers would be diverted from CTOL; the remaining 14% (from all other modes) would realize a time savings having an average value of $27.00.

Benefit to CTOL Airports

The chief transportation benefits of STOL not captured by STOL users would be a possible delay in the need for a major new airport in the Toronto area, and the reductions in passenger delays, congestion and noise at Malton and Dorval airports that would result from a diversion of CTOL traffic to STOL. For the Two STOLport Option, the reduction in traffic volumes at Dorval might also allow for some postponement in the construction of additional terminal capacity at Mirabel in the mid to late 1980s.

It was estimated that, as a result of the introduction of STOL service in the Corridor, the need for a major new airport in the Toronto area would be delayed by only two to four months, depending on the volume of CTOL traffic diverted from Malton to Toronto Island. The estimated economic benefit associated with the delay in constructing a major new airport is shown in Tables 8 and 9. A description of how these delay estimates and economic benefits were calculated is contained in Section 3 of Appendix D.

The benefit of reduced congestion would be greatest at Malton, where significant delays and congestion will be experienced in the early 1980s. STOL's greatest contribution would be in the reduction of peak-hour demand for runway use during periods when crosswind conditions restrict operations to the single North-South runway. It is estimated that in 1982, as a result of a diversion of traffic to STOL, between 2,400 and 4,800 CTOL flights, carrying 380,000-760,000 passengers, would each benefit from an average reduction in take-off or landing delay of between 1 and 8 minutes. Compared with other costs and benefits associated with STOL, these benefits are quite small, with total time savings to CTOL passengers being equivalent to a time savings of between 1 and 4 minutes <u>per STOL passenger</u>. Similarly, the reduction in CTOL operating costs resulting from the reduction in delay would not amount to more than 27¢ on a per STOL passenger basis.

Other STOL benefits relating to CTOL airport facilities (which are examined in Section 3 of Appendix D) are regarded as of less significance than the one just described. In particular, a diversion of short-haul domestic Air Canada flights would only provide minor relief to the terminal congestion problem at Malton, would result in only slight reductions in noise levels at both Malton and Dorval, and would permit only modest savings from a postponement of the construction of additional terminal facilities at Mirabel.

On the basis of the approximate value of the reduction in runway delay at Malton in the early 1980s, expressed on a per STOL passenger basis, and in recognition of the fact that this would be STOL's greatest contribution to relieving problems of delay, congestion and noise at Malton between 1980 and 1985, and that the benefit associated with a delay in the need for a major new airport in the Toronto area has already been accounted for, it was estimated that over the entire 1980-1990 planning period, "reduced congestion" benefits would have a total value of approximately 50¢ per STOL passenger for the Two STOLport Option and 25¢ per STOL passenger for the Single STOLport Option. These benefits are reflected in Tables 8 and 9.

Industrial Benefits

The development of an intercity STOL system in Canada could have two important effects on foreign DASH-7 sales. First, it should help to demonstrate that the aircraft will indeed be produced in substantial numbers, and that the Canadian government and Canadian carriers have confidence in the aircraft. This could cause some foreign carriers who have shown interest in the airplane to place firm orders. This would then establish a "launch market" for the aircraft, which is often argued to be important to the success of any new aircraft program. Without a Canadian STOL system the launch market would be much slower in developing, and, as a consequence, the total number of DASH-7 sales over the next few years could be much less.

The existence of a Canadian high density intercity STOL system could also have a positive effect on the development of similar high density intercity STOL systems in other countries. Such systems are probably less likely to develop without the feasibility and commercial viability of the high density intercity STOL concept being proven in Canada first. Once in place, the existence and successful operation of the Canadian system could provide a catalyst for the concept to gain approval elsewhere.

The expected present value of the "industrial benefits" has been estimated to be $42M, for both the Two STOLport and Single STOLport Options. This figure corresponds to an expected number of "induced" DASH-7 sales of 89 (52 to foreign air carriers and 37 to domestic carriers), and an average net economic benefit of $472,000 per DASH-7 sale.

Unlike the estimates of the other costs and benefits, the estimate of the industrial benefits is almost totally subjective. The degree of uncertainty associated with the value of the industrial benefits is reflected in the fact that two independent analyses have put the figure at \$10M-\$12M and \$60M-\$86M, respectively. The \$42M figure used in this analysis, is, in fact, a compromise between these two estimates.

The difficulty in estimating the value of the industrial benefits is related to both the problem of estimating the number of "induced" DASH-7 sales, and the problem of estimating the net economic benefit associated with any given number of induced sales. The uncertainty associated with the estimate of the number of "induced" DASH-7 sales is much greater than that associated with the <u>total</u> DASH-7 sales forecast, which is itself highly tentative. Further, the estimate of the economic value per induced DASH-7 sale depends on a number of important assumptions which are widely debated amongst officials. With different sets of assumptions, the average economic benefit per induced sale ranges from a low of some negative value to a high of approximately \$700,000.

Because of the highly subjective nature of the estimate of the industrial benefits, and the fact that this estimate is based upon numerous other studies and unpublished analyses, it has not been practical to include in this report a detailed explanation of how it was derived.

<u>Summary of Economic Benefits</u>

Summaries of the estimated present values of the three principal benefits, in total and per STOL passenger, are contained in Tables 8 and 9, respectively.

Table 8 Present Values of Total Economic Benefits[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Travel time saving[2]	91M	53M	31M	19M
Benefits to CTOL				
- Delay in new airport construction	13M	8M	11M	7M
- Reduced congestion[2]	5M	3M	2M	1M
Industrial benefits[3]	42M	42M	42M	42M
Total economic benefits	151M	106M	86M	69M

Table 9 Present Values of Total Economic Benefits per STOL Passenger[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Travel time saving per STOL passenger[3]	9.70	9.70	4.85	4.85
Benefits to CTOL airports per STOL passenger				
- Delay in new airport construction[4]	1.40	1.40	1.80	1.80
- Reduced congestion[3]	.50	.50	.25	.25
Industrial benefits per STOL passenger[4]	4.50	7.70	6.50	10.60
Total economic benefits per STOL Passenger	16.10	19.30	13.40	17.50

[1] Based on 10% discount rate for 1980-1990 period.

[2] Equals product of corresponding values from Table 9 and Table A8 (Appendix A).

[3] From text.

[4] Equals corresponding value from Table 8 divided by appropriate factor from Table A8 (Appendix A).

Summary of Total Economic Costs and Benefits

Estimates of the total economic costs (from Tables 4 and 5) and benefits (from Tables 8 and 9), in total and per STOL passenger, for the two STOL system alternatives, are contained in Tables 10 and 11. Thus, the present values of total economic costs are expected to exceed total economic benefits by $50M-$54M for the Two STOLport Option and by $32M-$44M for the Single STOLport Option (Table 10). On a per STOL passenger basis, total costs are expected to exceed total benefits by $5.50-$9.80 for the Two STOLport Option and by $6.50-$8.20 for the Single STOLport Option.

Sensitivity Analysis

It should be recognized that the evaluation of costs and benefits requires numerous subjective decisions concerning both the proper application of the cost-benefit methodology and individual problems of estimation. The most important methodological question concerns the appropriate choice of discount rate. The two most difficult problems of estimation are the value of trip time savings and the economic value of "induced" DASH-7 sales. Other assumptions and different estimation procedures could alter the overall estimation of the costs and benefits substantially.

Table 10 Summary of Present Values of Total Economic Costs and Benefits[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Total Economic Costs[2]	201M	160M	130M	101M
Total Economic Benefits[3]	151M	106M	86M	69M
Total Economic Costs Net of Economic Benefits	50M	54M	44M	32M

Table 11 Summary of Present Values of Total Economic Costs and Benefits, per STOL Passenger[1]

($1976)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Total Economic Costs per STOL Passenger[4]	21.60	29.10	19.90	25.70
Total Economic Benefits per STOL Passenger[5]	16.10	19.30	13.40	17.50
Total Economic Costs Net of Economic Benefits per STOL Passenger	5.50	9.80	6.50	8.20

[1] Based on 10% discount rate for 1980-1990 period.

[2] From Table 4.

[3] From Table 8.

[4] From Table 5.

[5] From Table 9.

The sensitivity of the estimates of the present value of total costs and total benefits to the social discount rate selected is shown in Table 12 for the Two STOLport Option and in Table 13 for the Single STOLport Option.[1] The values corresponding to 5% and 15% social discount rates (representative of "low" and "high" discount rates) are obtained from tables contained in the Appendices, as indicated in the footnotes to the two tables. It is apparent from these two tables that the present value of the total costs net of total benefits is reasonably insensitive to the discount rate selected. The greatest effect is with the Single STOLport Option, with "high" STOL passenger volumes, when the discount rate is reduced from 10% to 5%. In this case the present value of total costs net of total benefits increases from $44M to $53M.

Table 14 gives estimates of the sensitivity of the present value of total costs net of total benefits to errors in the estimation of the principal costs and benefits. The 80% "confidence ranges" are expected to contain the actual total economic costs net of total benefits with a probability of 80%. This is equivalent to saying that it is estimated that there is only a 10% chance that the actual total costs net of benefits are below the lower limits, and an equal likelihood that they are above the upper limits. Thus, in the case of the Two STOLport Option, with the high STOL passenger volumes, it is estimated that there is a 10% chance that total benefits actually exceed total costs by at least $20M, and an equal likelihood that total costs actually exceed total benefits by at least $120M.

---

[1] Benefits are here expressed as negative costs.

Table 12 Summary of Present Values of Total Costs and Benefits as Functions of Social Discount Rate, Two STOLport Option

($1976, in millions)

	High Traffic Volume Social discount rate			Low Traffic Volume Social discount rate		
	5%	10%	15%	5%	10%	15%
Infrastructure costs[1]	100	91	83	100	91	83
Increased transportation costs[2]	134	100	76	79	59	45
Increased cost of Hydro Quebec Project	10	10	10	10	10	10
Travel time savings[3]	-142	-91	-60	-84	-53	-35
Benefit to CTOL airports[4]	-16	-18	-18	-10	-11	-11
Industrial benefits[5]	-42	-42	-42	-42	-42	-42
Total costs net of benefits	44	50	49	53	54	50

Table 13 Summary of Present Values of Total Costs and Benefits as Functions of Social Discount Rate, Single STOLport Option

($1976, in millions)

	High Traffic Volume Social discount rate			Low Traffic Volume Social discount rate		
	5%	10%	15%	5%	10%	15%
Infrastructure costs[1]	58	58	56	58	58	56
Increased transportation costs[2]	97	72	55	59	43	33
Travel time savings[3]	-50	-31	-21	-30	-19	-13
Benefit to CTOL airports[4]	-10	-13	-14	-7	-8	-9
Industrial benefits[5]	-42	-42	-42	-42	-42	-42
Total costs net of benefits	53	44	34	38	32	25

1 From Table B8 (Appendix B).

2 From Table C13 (Appendix C).

3 Equals product of corresponding values from Table 9 and Table A8 (Appendix A).

4 Equals values in Table D11 (Appendix D) plus products of per passenger "reduced congestion" benefits from Table 9 and corresponding factors from Table A8 (Appendix A).

5 Estimate of industrial benefits only available for 10% discount rate; same value assumed for 5% and 15% rates.

Table 14 Expected Variation of Present Value of Total Costs Net of Total Benefits, Due to Errors in Estimation[1]

($1976, in millions)

	Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume
Expected present values of total costs net of total benefits	50	54	44	32
80% confidence ranges				
Lower limit	-20	- 0	- 6	-10
Upper limit	120	108	94	74
Probability that total costs exceed total benefits	.82	.90	.87	.83

[1] Based upon a 10% social discount rate.

Another sensitivity measure is the estimated probability that total costs exceed total benefits, which is given in the last line of Table 14. From these estimates it would appear unlikely that total benefits actually exceed total costs.

The estimates contained in Table 14 were derived from subjective appraisals of the precision of the individual estimates of the three principal costs and three principal benefits. These subjective appraisals are given in Tables 15 and 16, in the columns labelled "80% confidence ranges". For example, it was estimated that the actual value of "increased transportation costs" would fall within a range of ±30% of the estimated (or "expected") value of that cost, with a probability of 80%. In the case of the Two STOLport Option, with high passenger volume, the actual increased transportation cost is therefore expected to fall between $60M and $140M ($100M ± 40%) with a probability of 80%. Note that of the six principal costs and benefits, confidence in the precision of the estimates is greatest for the STOLport infrastructure costs and the increased Hydro Quebec project costs, and least for the industrial benefits.

If the probability distributions of the estimates of the six principal costs and benefits were known, the distribution of the sum of these estimates (which equals total costs net of benefits) would also be known. For purposes of analysis, it has been assumed that for each STOL system option and each level of passenger volume (i.e., "high" and "low"), the estimates of the six principal costs and benefits are independently distributed Normal random variables, whose means are the "estimated values" given in Tables 15 and 16. In this case, the variance of each of these random variables is easily calculable from the information contained in the columns labelled "80% confidence range". The means and variances of the six estimates are then each summed to yield the means and variances of the estimates of total costs net of total benefits. Once these have been obtained, it is a simple matter to calculate the "80% confidence ranges" and "probabilities that total costs exceed total benefits", contained in Table 14.

Table 15 Estimated Variation of Estimates of
Principal Costs and Benefits, Two STOLport Option[1]

($1976, in millions)

Principal costs and benefits	High Volume Estimated Value	High Volume 80% confidence range	Low Volume Estimated Value	Low Volume 80% confidence range
Infrastructure cost	91	±30%	91	±30%
Increased transportation cost	100	±40%	59	±40%
Increased cost of Hydro Quebec Project	10	±30%	10	±30%
Travel time savings	-91	±40%	-53	±40%
Benefit to CTOL airports	-18	±50%	-11	±50%
Industrial benefits	-42	±80%	-42	±80%

Table 16 Estimated Variation of Estimates of
Principal Costs and Benefits, Single STOLport Option[1]

($1976, in millions)

Principal costs and benefits	High Volume Estimated Value	High Volume 80% confidence range	Low Volume Estimated Value	Low Volume 80% confidence range
Infrastructure cost	58	±30%	58	±30%
Increased transportation cost	72	±40%	43	±40%
Travel time savings	-31	±40%	-19	±40%
Benefit to CTOL airports	-13	±50%	-8	±50%
Industrial benefits	-42	±80%	-42	±80%

1 Based upon a 10% social discount rate.

SECTION 3

CONCLUSIONS OF ECONOMIC EVALUATION

3. CONCLUSIONS OF ECONOMIC EVALUATION

The cost-benefit study concludes that, for both options considered, it is probable that total economic costs exceed total economic benefits. This means that, barring major errors in the estimation of costs and benefits, a STOL system in the Quebec-Windsor corridor cannot be supported on economic grounds when it is compared with the base case alternative: namely, the continuation of service by existing transportation modes in the Corridor, and development of the Toronto Island Airport site for market-oriented housing. Of the two STOL system alternatives considered, the Single STOLport Option was found to have the smaller net economic disbenefit.

APPENDIX "A": PASSENGER FORECASTS

APPENDIX "A"

PASSENGER FORECASTS

STOL passenger forecasts have been developed for each of several routes by a two-stage process. The first stage was to estimate, in the absence of STOL, future origin-destination (as opposed to connecting) passenger volumes for each passenger mode used on each route. The second stage was to estimate, for each mode and each route, the proportion of traffic which would be diverted to a STOL service.[1]

Annual passenger forecasts for the period 1980-1990 have been developed for various Quebec and Ontario city pairs, for conventional air (CTOL), rail, bus and auto passenger modes.

Estimates of CTOL and bus traffic were based largely on the projections developed by the CTC for their Intercity Passenger Transport Study of 1970.[2] Rail passenger volumes were estimated on the basis of 1975 CN origin/destination passenger ticket lift figures. The 1976 projection was obtained by assuming a 10% growth rate, to reflect road speed limit changes and energy costs. Volumes for the following years up to 1980 were calculated on the assumption of an annual 3% growth rate, which was based upon the slow growth trend experienced between 1965 and 1975. Auto traffic, not estimated in the CTC study, was assumed to grow at a rate of 5% per year from 1970 levels.

---

1 The related assumption that STOL would not generate a significant number of new trips appears to be confirmed by Airtransit passenger survey data.

2 Canadian Transport Commission, Intercity Passenger Transport Study, 1970, p. 51.

The CTOL air traffic projections developed by the CTC in 1970 (after the adjustments in rail traffic described above) were compared with actual traffic volumes experienced during the years 1970-1974 in order to evaluate their accuracy. The projections proved to be exceedingly good for the Toronto-Montreal, Montreal-Ottawa and Toronto-Sudbury routes, and somewhat low on the other routes examined. The CTC projections were therefore used directly for these three routes.[1] For each of the other routes the forecasts were adjusted (via straight-line extrapolation) to take into account trends which developed during the 1970-1974 period.[2]

Traffic estimates for each of the four existing modes -- CTOL, rail, bus and auto -- are contained in Table A1 for each of seven eastern domestic routes judged capable of supporting a DASH-7 service during the period 1980-1990 (Montreal-Toronto, Montreal-Quebec, Montreal-Ottawa, Toronto-Ottawa, Toronto-Windsor, Toronto-London and Toronto-Sudbury). These estimates assume that a competing STOL service would not exist. Several other Toronto-based domestic routes could support a Twin Otter service but the relatively small number of additional passengers flown would not significantly influence either infrastructure cost per passenger or carrier operating economics.

---

[1] Note that for each option examined, the Montreal-Toronto route alone accounts for at least 50% of the total STOL passenger volume.

[2] Air traffic forecasts contained in CTC Research Publication No. 29 (1972) were found to provide exceedingly poor (low) estimates for the period 1971-1974, for virtually all routes. In comparison with the projections developed here, Air Canada traffic forecasts for 1977-78 were 10% less for the Montreal-Toronto route, 5% less for the Toronto-Ottawa route, and 13% greater for the Montreal-Ottawa route.

Table A1 Projected Annual One-Way Traffic Forecast, by Mode, 1980 - 1990
(In Thousands of Passengers)

Montreal-Toronto

	CTOL	RAIL	BUS	AUTO
1980	1530	524	130	1580
1981	1628	540	138	1670
1982	1731	556	147	1766
1983	1842	573	156	1867
1984	1959	590	166	1974
1985	2084	608	176	2087
1986	2202	626	186	2201
1987	2326	645	197	2322
1988	2457	664	208	2449
1989	2596	684	220	2583
1990	2742	704	232	2725

Montreal-Ottawa

	CTOL	RAIL	BUS	AUTO
1980	147	198	995	3986
1981	156	203	1055	4199
1982	165	210	1118	4423
1983	175	216	1185	4659
1984	186	222	1257	4907
1985	197	229	1332	5169
1986	208	236	1404	5439
1987	219	243	1480	5722
1988	231	250	1559	6021
1989	243	258	1642	6335
1990	256	265	1732	6665

Montreal-Quebec

	CTOL	RAIL	BUS	AUTO
1980	116	153	303	1095
1981	118	158	318	1150
1982	120	162	334	1207
1983	122	167	351	1267
1984	124	172	369	1331
1985	126	177	387	1397
1986	128	183	406	1467
1987	130	188	427	1540
1988	132	194	448	1617
1989	134	200	470	1698
1990	136	206	494	1783

Toronto-Ottawa

	CTOL	RAIL	BUS	AUTO
1980	690	80	191	898
1981	723	83	202	945
1982	752	85	214	995
1983	788	88	227	1047
1984	820	91	240	1102
1985	851	93	254	1160
1986	885	96	265	1220
1987	915	99	267	1283
1988	949	102	288	1349
1989	980	105	300	1419
1990	1014	108	313	1492

Toronto-London

	CTOL	RAIL	BUS	AUTO
1980	64	281	266	1140
1981	65	295	279	1197
1982	66	310	293	1257
1983	68	325	308	1320
1984	69	341	323	1386
1985	70	358	339	1455
1986	71	376	356	1528
1987	72	395	374	1604
1988	73	415	393	1684
1989	74	435	412	1769
1990	75	457	433	1857

Toronto-Windsor

	CTOL	RAIL	BUS	AUTO
1980	108	331	163	440
1981	110	347	171	462
1982	111	365	180	485
1983	113	383	189	509
1984	114	402	198	534
1985	115	422	208	561
1986	117	443	218	589
1987	118	465	229	619
1988	120	489	241	649
1989	121	513	252	682
1990	122	539	265	716

Toronto-Sudbury

	CTOL	RAIL	BUS	AUTO
1980	160	170	96	528
1981	181	170	101	554
1982	205	170	106	582
1983	233	170	111	611
1984	264	170	117	642
1985	299	170	123	674
1986	339	170	129	708
1987	384	170	136	743
1988	436	170	142	780
1989	494	170	150	819
1990	560	170	157	860

To identify possible eastern transborder STOL routes the 1974 CTOL o/d (origin/destination) passenger volumes (one-way trips) for each of the seven routes considered in this study and for the various Central Canadian transborder routes which have been suggested as possibilities for STOL have been summarized in Table A2. Also included in this table are stage lengths and differences between STOL and CTOL one-way average door-to-door trip times.[1]

To put these figures into perspective, consider the operation of a DASH-7 service on the 193 mile Toronto-Windsor route. It is expected that the CTOL o/d traffic on this route would be approximately 109,000 in 1980. If STOL were to divert 40% of this traffic plus 6% of rail traffic, 2% of bus traffic and 1% of auto traffic, then the total STOL passenger demand (of which 68% would be from CTOL) could be serviced by one DASH-7, with an average load factor of 55% and an annual utilization of only 1960 hours.[2]

It would appear that the only Central Canadian transborder routes which might be considered for DASH-7 STOL service are Montreal-Boston, Toronto-Cleveland and Toronto-Detroit. In view of the passenger volumes contained in Table A2, however, the inclusion of these three routes would not alter the overall results appreciably. The high-volume Montreal-New York and Toronto-New York routes involve distances considered too great to make STOL competitive with CTOL in terms of travel-time, particularly if STOL were required to operate out of Kennedy Airport, which is a distinct possibility.[3]

---

[1] Trip times include total elapsed time between trip origin and trip destination. Trip times for domestic routes are taken from Table D3 in Appendix D. Transborder trip time differentials assume that the U.S. trip end would be at a conventional airport.

[2] These potential market penetration levels are discussed in detail over the next few pages.

[3] Air Canada, which is the only Canadian carrier permitted to operate out of New York, is presently required to confine its operations to Kennedy Airport. The three American carriers servicing these two routes operate out of LaGuardia and Newark airports, both of which are much closer to downtown New York City than is Kennedy.

Table A2

1974 CTOL o/d Passenger Volumes, Stagelengths and One-Way Trip Time Savings of STOL over CTOL, for Various Eastern Routes.

ROUTE	1974 CTOL o/d passengers (000's)	Stagelengths (Statute miles)	Trip Time Savings STOL over CTOL (minutes)
Toronto-Montreal	966	315	19
Montreal-Ottawa	102	102	11
Montreal-Quebec	117	146	11
Toronto-Ottawa	494	226	8
Toronto-London	26	88	20
Toronto-Windsor	109	194	7
Toronto-Sudbury	95	211	6
Montreal-New York	389	333	-5
Montreal-Boston	110	253	5
Toronto-New York	509	336	-4
Toronto-Cleveland	77	193	7
Toronto-Detroit	59	218	7
Toronto-Pittsburgh	22	222	7
Toronto-Syracuse	6	181	11
Windsor-Chicago	no service	253	5
Toronto-Boston	no service	330	-5

The level of penetration by STOL into other modes is assumed to be closely related to the total trip time savings which STOL could offer over CTOL, in relation to the difference between STOL and CTOL fares.[1] The average time savings resulting from STOL was found not to vary significantly with the volume of STOL traffic.[2] The STOL fare including user charges, would be dependent, however, on the extent to which infrastructure costs would be recovered from the STOL users. Thus, as passenger volumes were to go down, fares would go up, further decreasing passenger volumes, etc. To get around this chicken and egg situation, a STOL fare level has not been assumed in determining STOL penetrations into other modes; rather, reasonably wide potential market penetration ranges have been adopted, based upon potential time savings only.

One-way trip time savings (developed in Appendix D) are summarized in Table A3, and potential market penetration levels used in this study are contained in Table A4.

The Airtransit Twin Otter service between Montreal and Ottawa (Rockcliffe) saved travellers roughly 25-30 minutes each way in total trip time over CTOL. A DASH-7 STOL service operating out of Uplands[3] in Ottawa would perhaps be a more comfortable and attractive service, but would offer less time savings - only 11 minutes. Considering these factors, it has been assumed that a Montreal-Ottawa (Uplands) STOL service could potentially divert between 30% and 50% of the CTOL o/d traffic.[4]

---

[1] Naturally, other factors -- especially frequency of service and access/egress costs -- would also influence ridership; however, we have assumed that time and fares would be the most important factors.

[2] It might be conjectured that travellers with the greatest potential reduction in access/egress time would, other things being equal, be the first to switch to STOL (see Appendix D).

[3] The assumed location of the Ottawa STOLport (See Appendix B).

[4] Here "diversion" is expressed in terms of potential STOL demand. Numbers of passengers actually flown by STOL is calculated to be potential STOL demand times the fraction of scheduled STOL flights actually flown (i.e., that were not cancelled).

Table A3 STOL One-Way Trip Time Savings

Route	CTOL Trip Time (min.)	STOL Trip Time (min.)	STOL Time Savings over CTOL (min.)	STOL Time savings over CTOL as % of Trip Time: CTOL	Rail	Bus	Auto
Montreal[1]-Toronto	165	146	19	12	5	4	5
Dorval-Toronto	165	167	-2	0	0	0	0
Montreal[1]-Ottawa	126	115	11	9	5	6	8
Montreal[1]-Quebec	122	111	11	9	6	5	6
Toronto-Ottawa	151	143	8	5	2	2	3
Toronto-London	119	99	20	17	11	10	15
Toronto-Windsor	129	122	7	5	2	2	3
Toronto-Sudbury	131	125	6	5	1	2	2

[1] Victoria Carpark

Table A4 STOL Market Penetration Into Other Modes
(% of o/d passengers diverted to STOL)

Route	CTOL		RAIL		BUS		AUTO	
	high	low	high	low	high	low	high	low
Montreal-Toronto	50	30	14	8	5	3	2	1
Dorval-Toronto	40	25	8	4	3	1.5	1	0.5
Montreal-Ottawa	50	30	14	8	5	3	2	1
Montreal-Quebec	50	30	14	8	5	3	2	1
Toronto-Ottawa	40	25	8	4	3	1.5	1	0.5
Toronto-London	50	30	14	8	5	3	2	1
Toronto-Windsor	40	25	8	4	3	1.5	1	0.5
Toronto-Sudbury	40	25	8	4	3	1.5	1	0.5
Airtransit's Montreal-Rockcliffe Actuals	33.5		11.5		3.6		1.4	

Further, it was assumed that the STOL penetration into CTOL traffic would fall within the same range for all routes in which estimated total trip time savings were comparable to, or better than, estimated time savings on the Montreal-Ottawa route. For routes with smaller time savings the range was assumed to be 25% - 40%.[1]

The penetration of STOL into each of the other three modes would seem to be more closely related to the time savings of STOL over CTOL than to the time savings of STOL over these other modes. This is because of the relative similarity of STOL and CTOL, in terms of trip time, fare, convenience, comfort, etc., and the fact that the trip time savings offered by CTOL have not been of sufficient importance to passengers using the three other modes to cause them to choose CTOL in the absence of STOL. One might also expect the importance of the marginal time savings of STOL over CTOL to diminish as total trip times for those other modes increase. The percentage penetrations of STOL into these other modes are therefore assumed to vary with the trip time savings of STOL over CTOL expressed as a percentage of the total trip times required by each of these modes. Penetration ranges were first developed for the Montreal-Ottawa route on the basis of Airtransit's experience, and then adjusted for other routes on the basis of percentage travel time savings.[2] These figures are contained in Table A3 for each mode and for each of the seven routes.

---

1 Air Canada personnel have estimated that, for the first year of DASH-7 STOL operations, STOL penetration levels into CTOL o/d traffic would be 36% for the Montreal-Toronto route, 50% for the Montreal-Ottawa route and 38% for the Toronto-Ottawa route.

2 For the first year of DASH-7 STOL operation, Air Canada personnel have estimated STOL penetrations into surface traffic of 2% for the Montreal-Toronto route, 2.5% for the Toronto-Ottawa route and 3% for the Montreal-Ottawa route. These penetration levels assumed that STOL and CTOL fares would be the same.

Estimated STOL demand, for each route and each year, has been obtained by multiplying the CTOL, rail, bus and auto passenger forecasts in Table A1 by the appropriate penetration levels in Table A4, and then summing the products over all four modes. Estimated numbers of STOL passengers actually flown, by route and year were obtained by multiplying these STOL demand forecasts by the percentage of scheduled STOL flights which would be completed (i.e., not cancelled). A 93% DASH-7 flight completion performance level has been assumed for all routes.[1] Projected STOL one-way passenger volume ranges are contained in Tables A5 and A6 for the two STOL system options considered in this study.

Table A5

Projected STOL (One-Way) Passenger Volumes, 1980-1990[1], Two STOLport Option

(In Thousands of Passengers)

Low Penetration Levels

ROUTE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Montreal-Toronto	484	513	544	578	613	650	686	724	763	805	849
Montreal-Ottawa	120	127	133	141	149	157	165	173	182	191	201
Montreal-Quebec	62	64	66	68	70	72	74	76	78	81	83
Toronto-Ottawa	168	176	183	192	200	207	216	223	232	239	248
Toronto-London	57	59	61	64	66	69	71	74	77	81	84
Toronto-Windsor	40	41	42	43	44	46	47	48	50	51	53
Toronto-Sudbury	46	51	57	63	71	79	89	99	111	125	141
Total	979	1033	1089	1151	1215	1283	1350	1421	1497	1576	1661

High Penetration Levels

ROUTE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Montreal-Toronto	815	864	916	973	1032	1095	1155	1217	1284	1354	1428
Montreal-Ottawa	214	226	238	251	265	279	293	308	324	340	358
Montreal-Quebec	108	111	114	118	121	125	129	133	137	141	146
Toronto-Ottawa	276	289	301	315	328	341	355	367	381	393	407
Toronto-London	100	104	108	112	117	122	127	132	137	143	149
Toronto-Windsor	73	75	78	80	82	85	88	90	93	96	99
Toronto-Sudbury	79	87	97	108	120	133	148	166	186	208	233
Total	1667	1760	1855	1959	2068	2182	2297	2416	2544	2679	2822

[1] Estimates assume that 7% of scheduled flights would be cancelled and therefore that 93% of potential STOL demand would be actually realized.

---

[1] Airtransit personnel have forecasted this level of DASH-7 flight completion performance for the Montreal-Toronto, Montreal-Ottawa and Toronto-Ottawa routes.

Table A6

Projected STOL (One-Way) Passenger Volumes, 1980-1990[1], Single STOLport Option

(In Thousands of Passengers)

Low Penetration Levels

ROUTE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Montreal-Toronto	384	408	433	460	488	519	548	578	610	664	679
Toronto-Ottawa	170	178	185	194	202	210	218	226	234	242	251
Toronto-London	57	59	61	64	66	69	71	74	77	81	84
Toronto-Windsor	41	43	44	45	46	48	49	50	52	53	55
Toronto-Sudbury	47	52	58	64	72	80	90	100	113	127	142
Total	700	741	783	829	877	927	978	1031	1088	1148	1213

High Penetration Levels

ROUTE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Montreal-Toronto	626	665	705	749	795	844	891	940	991	1046	1104
Toronto-Ottawa	276	289	301	315	328	341	355	367	381	393	407
Toronto-London	100	104	108	112	117	122	127	132	137	143	149
Toronto-Windsor	73	75	78	80	82	85	88	90	92	96	99
Toronto-Sudbury	79	87	97	108	120	133	148	166	186	208	233
Total	1156	1760	1290	1366	1444	1527	1610	1696	1790	1888	1994

[1] Estimates assume that 7% of scheduled STOL flights would be cancelled and therefore that 93% of potential STOL demand would be actually realized.

The STOL passenger forecasts contained in Tables A5 and A6 may be compared with an independent set of traffic projections recently developed by the Toronto Area Airports Project (TAAP) for use by the Toronto Island Airport Intergovernmental Staff Forum (Table A7). TAAP's forecasts were developed by extrapolating total market demand (all modes combined) by route, from past data and then estimating share of market, by mode, for each route, by a modified regression technique, in which travel time and cost were the independent variables used for each mode. TAAP's forecasts would appear to suggest that actual STOL traffic volumes would probably be closer to the "low penetration levels" given in Tables A5 and A6, than to the "high penetration levels".

Certain calculations in Appendices B and C, and in the body of the report, require knowledge of the present value of a $1 benefit realized by (or a $1 charge paid by) all STOL passengers. These present values, for both STOL system options, for high and low STOL passenger volumes, and for social discount rates of 5%, 10% and 15%, are contained in Table A8.

Toronto Area Airports Project

Projected STOL (One-Way) Passenger Volumes[1]
1980-1990

(In thousands of Passengers)

ROUTE	1980	1985	1990
Toronto-Montreal			
High	399	531	701
Most Likely	333	527	695
Low	206	273	362
Toronto-Ottawa			
High	242	320	425
Most Likely	174	312	389
Low	93	123	163
Toronto-London-Windsor[2]	105	139	184
Most Likely	81	115	151
Low	55	72	96
Toronto-Sudbury-N.E. Ontario[3]			
High	25	34	46
Most Likely	18	25	32
Low	11	15	20
Toronto-St. Catharines			
High	10	13	17
Most Likely	7	12	15
Low	4	6	8
Toronto-Kingston			
High	8	10	14
Most Likely	6	10	13
Low	4	5	6
Total			
High	791	1050	1389
Most Likely	621	1003	1297
Low	375	495	658

[1] Source: Studies of Alternative Aviation Uses for Toronto Island Airport Site, Study B, Alternative Aviation Uses Report, Scenario 3, March 1977.

[2] With feeder service from Sarnia to London. Passengers shown are on Toronto-London leg and are cumulative of Toronto-Windsor, Toronto-London and Toronto-Sarnia.

[3] Passengers are cumulative of Toronto-Sudbury and Northeastern Ontario.

Table A8

Present Value of a $1.00 Benefit Realized by all STOL Passengers

(Millions of 1976 dollars)

	STOLport Users[1]				All STOL Passengers			
	Victoria Carpark (Montreal)		Toronto Island[2] (Toronto)		Two STOLport Option		Single STOLport Option	
	High Volume	Low Volume	High Volume	Low Volume	High Volume	Low Volume	High Volume	Low Volume
5%	10.06	5.91	11.96	7.12	14.69	8.67	10.28	6.24
10%	6.37	3.74	7.57	4.51	9.31	5.49	6.51	3.95
15%	4.21	2.47	5.00	2.97	6.14	3.62	4.29	2.60

[1] Enplaning plus deplaning

[2] For Two STOLport Option

APPENDIX "B": STOLPORT COSTS

APPENDIX "B"

STOLPORT COSTS

STOLport costs can be conveniently broken down into three categories: initial capital costs, costs of an on-going nature (annual costs) and economic costs associated with the alternative uses of publicly-owned land. These topics will be dealt with in Sections 1, 2 and 3 below. The total cash and economic costs directly associated with the provision of STOLport infrastructure will be presented and discussed in Section 4.

1. CAPITAL COSTS

Estimated capital costs for constructing downtown STOLports in Montreal (Victoria Carpark) and Toronto (Toronto Island) are provided in Table B1. Design parameters and sketches of STOLport configurations used for estimation purposes are provided in Table B2 and Figures B1 and B2. Design parameters and construction cost estimates were initially developed for both STOLports by the Canadian Air Transportation Administration (CATA) of Transport Canada during the summer of 1975, with some minor revisions made in January, 1976. Subsequently, in connection with studies conducted for the Toronto Island Intergovernmental Staff Forum (ISF), CATA developed alternative cost estimates for the Toronto STOLport, based upon a somewhat different design concept. In the summer of 1977, both sets of construction cost estimates were revised slightly to reflect a more utilitarian STOL system concept than had originally been envisioned.

Both the Montreal and Toronto sites were determined to be the only feasible "downtown" or "near-downtown" sites available for use as a STOLport, given the restrictions imposed by aeronautical zoning and air traffic control constraints.

TABLE B1 STOLPORT CAPITAL COSTS

(millions of $1976)

Type of Cost	Victoria Carpark (Montreal)	Toronto Island Airport
Access	0.2 (road)	3.9 (pedestrian tunnel)
Parking	0.5 (ground level)	3.5 (structure, incl. land cost)
Site Preparation (demolition, drainage and grading)	16.7	1.1
Air Terminal Bldg.	3.3	3.5
Maintenance Garage	0.5	0.5
Pavement (incl. runways, taxiways and aprons)	1.0	2.2
Utilities (power, electrical, gas, water and sewer)	1.4	1.9
Control Tower, Radar and Navigational Aids	2.4	2.4
Management, Development and Coordination	4.0	1.8
Contingencies	5.2	- (incl. above)
Equipment and Machinery	0.7	0.7
TOTAL	35.9	21.5

TABLE B2 STOLPORT DESIGN PARAMETERS

	Victoria Carpark (Montreal)		Toronto Island Airport	
	All DASH-7	50% DASH-7 50% DHC-6	All DASH-7	50% DASH-7 50% DHC-6
Runway Capacity				
# movements/hr.	26	24	26	24
# passengers/hr.[1]	1,040	662	1,040	662
# passengers/yr. (000's)[3]	2,300	1,500	2,300	1,500
Terminal Design Capacity				
# passengers/peak hr.	800		800	
# passengers/yr. (000's)[3]	1,800[2]		1,800[2]	
Forecasted Passengers Per Year (000's)[4]				
low estimate				
1980	666[3]		700 - 797	
1985	879		927 - 1,054	
1990	1,133		1,213 - 1,377	
high estimate				
1980	1,137		1,156 - 1,345	
1985	1,499		1,527 - 1,778	
1990	1,932		1,994 - 2,318	

---

1 Based upon 80% load factor in peak period.

2 Based on Airtransit's experience of 93% of traffic occurring on weekdays and 28% of each weekday's traffic falling in a 2 1/2 hour morning peak period.

3 For Two STOLport Option. (Appendix A)

4 Low-end of range corresponds to Single STOLport Option; high end of range corresponds to Two STOLport Option.

Figure B1 - Montreal STOLport

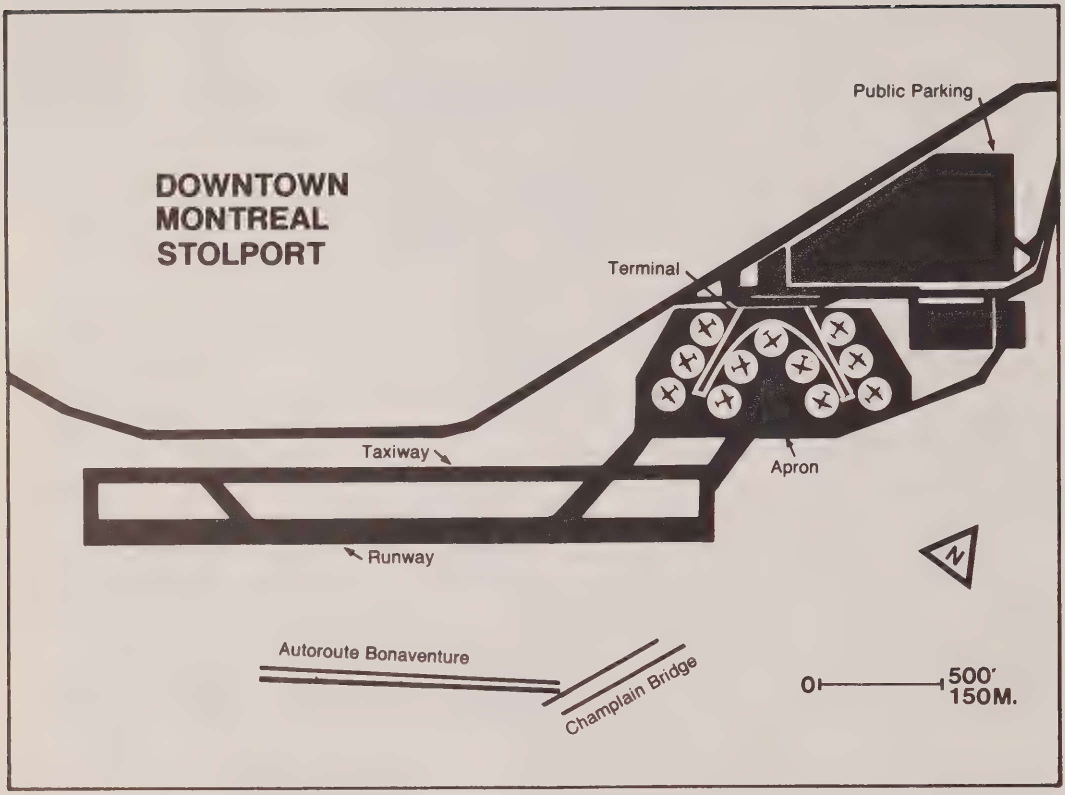
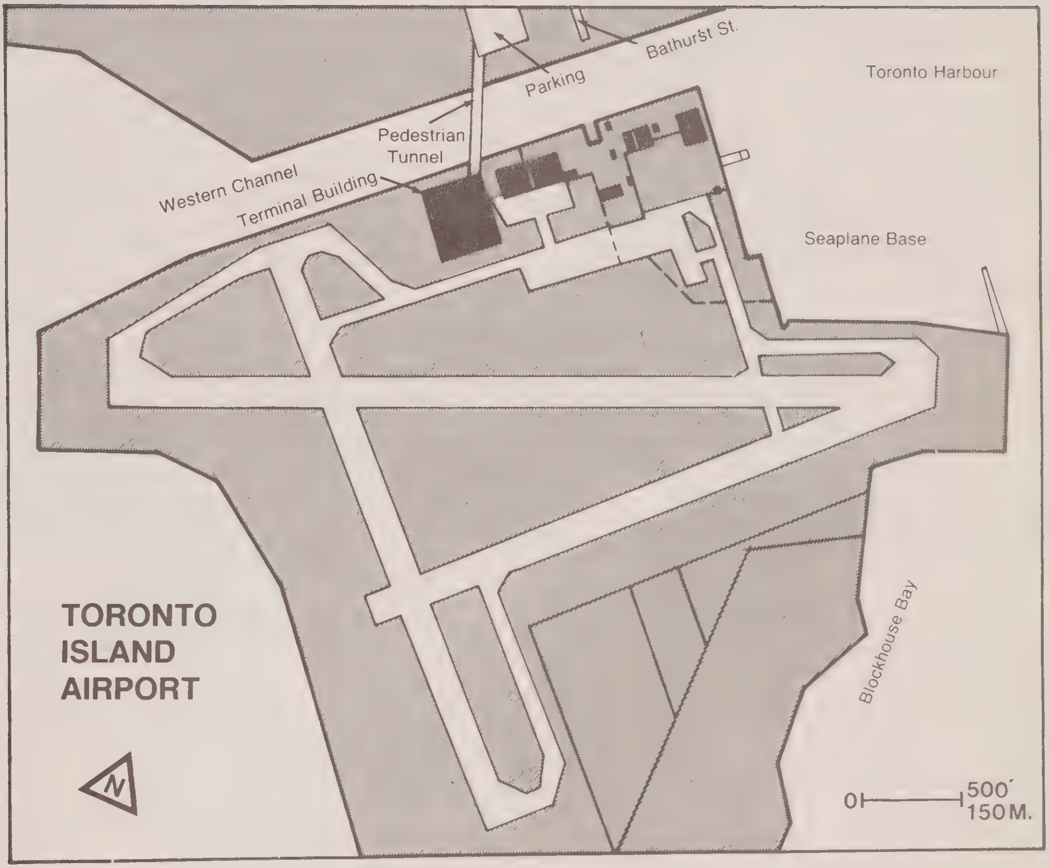


Figure B2 - Toronto STOLport



A design pericd of at least one year would be required for each STOLport. Following the award of contracts, periods of approximately 2-2 1/2 years would be required for the construction of each STOLport. For purposes of analysis, it has been assumed that the STOLports would be available for use in 1980, and that the timing of expenditures would be as indicated in Table B3[1].

Two other Canadian cities - Ottawa and Quebec City - were also considered as possible locations for STOLport facilities. In view of the cost and availability of suitable STOLport sites, the cost of constructing and maintaining the STOLport facilities, the degree of excess capacity at the existing CTOL airports in these cities, projected traffic volumes, and finally, the potential access/egress cost and total trip time savings for users of such facilities, it was concluded that at these two locations the benefits resulting from the provision of STOLport facilities separate from existing CTOL facilities would be so small in relation to the costs involved that they could be ruled out from serious consideration at this time. It is therefore assumed that STOL service from all cities other than Montreal and Toronto would be based at existing CTOL airports. The increased capital costs necessary to support a STOL service at existing airports is expected to be relatively insignificant.

A brief discussion of the major factors influencing capital costs at the two STOLport sites investigated now follows.

---

1 The phasing of the STOLport construction costs indicated in Table B3 minimizes the present value of the capital and operating costs over the 1980-1990 planning period.

TABLE B3 TIMING AND PRESENT VALUES OF STOLPORT CAPITAL COSTS

(millions of $1976)

	Victoria Carpark (Montreal)	Toronto Island Airport
Total in 1978	24.2	9.0
Total in 1979	10.6	11.0
Total in 1985	1.1	1.5
Total Project Cost	35.9	21.5
Present Values to Jan., 1976		
- 5% discount rate	30.3	17.7
- 10% discount rate	25.8	14.9
- 15% discount rate	22.2	12.6

Montreal STOLport (Victoria Carpark)

The extremely high capital cost associated with the Montreal site is primarily due to the probable need for a massive excavation and fill operation, to provide a proper footing for the runway, taxiway, apron and buildings. The site - Victoria Carpark - is a former garbage dump. The decomposition of organic material results in both a highly unstable surface and in the release of methane gas. The only satisfactory design solution for establishing a permanent STOLport facility may well be to remove the garbage (averaging thirty feet deep) and replace it with suitable fill in those areas where a sturdy base is essential.[1] The garbage would most likely be removed by barge, although an acceptable destination has not been identified; replacement fill would likely be trucked in.[2].

The Bonaventure Auto Route to the east of the site and the Hydro transmission lines on Victoria Bridge create a significant aeronautical zoning problem. Without elevating the runway above existing grade it would not be possible to use any existing aircraft other than the DASH-7 for commercial operations. To design the facility for both DHC-6 (Twin Otter) and DASH-7 use, it would be necessary to elevate the runway, apron and terminal approximately twenty feet above existing grade and to relocate the existing Hydro transmission lines. This would increase the capital cost estimate in Table B1 by approximately $25.5 million. Thus, it is assumed that STOL operations at Victoria Carpark would be confined to the use of the DASH-7.

---

1 In the terminal area the alternative of concrete piles, together with a gas control system, has been examined and found to be more expensive.

2 As an illustration of the magnitude of the excavation and fill operation, over 100,000 tandem-truck loads of replacement fill would be needed.

To the west of the site, there are no existing structures which would create hazards to flying operations;[1] however, STOL operations would restrict future high rise development in part of the eastern portion of Verdun. At present, there appear to be no development plans for this area, and it is not anticipated that the government would be liable for any damages due to the imposition of aeronautical zoning restrictions.

Hydro Quebec currently has plans for constructing three, 315 KV overhead power lines to the northwest and east of this site which would interfere with DASH-7 operations. If the site were developed as a STOLport, Hydro Quebec would have to run underground a portion of one line (which is to be constructed northwest of the site, connecting the Atwater and Viger power stations), at an additional cost of approximately $5.2M, and would have to reroute, or run underground, two lines which are to cross the St. Lawrence River (joining the Viger and Hertel stations), at an additional cost of either $5.0M (for re-routing the overhead lines) or $28M-$30M (for running the lines underground), depending upon whether it would prove feasible to re-route the lines.[2] Thus, Hydro Quebec's total project costs would be increased by at least $10M. In addition, a decision to construct a STOLport at the site would delay the construction of the power lines for approximately one year, which, according to Hydro Quebec officials, could result in serious power shortages on the South Shore in the late 1970s.

It is expected that STOL operations would not create an unacceptable level of noise in the vicinity of the STOLport. Although a permanent STOL system would involve a greater number of flights per day than the Airtransit Demonstration Service, the DASH-7 is much quieter than the Twin Otters used by Airtransit, and there were no noise problems at the Montreal STOLport during the period when the Demonstration Service was in operation.

---

1 The Bonaventure Expressway severely constrains the siting of the runway, however.

2 These cost estimates have been provided by Hydro Quebec.

Toronto STOLport (Toronto Island)

Except for the problem of providing access, the Toronto Island site is ideal for STOL operations. The site is close to downtown Toronto; there are no existing or potential aeronautical zoning problems; and noise levels over inhabited areas would be minimal.

The ISF concept, adopted for costing purposes, assumes that access would be by a combination pedestrian tunnel/freight conveyor system, with automobile parking facilities provided on the mainland side, at the foot of Bathurst Street. The cost of the tunnel/conveyor system and associated road improvements is estimated at $3.9 million. The cost of the parking structure ($1.1 million) and four-acre site needed for the garage ($2.4 million) total approximately $3.5 million.

As an alternative to the pedestrian tunnel/conveyor system, a car bridge has been considered and rejected. Although a car bridge would obviate the need for a parking structure on the mainland, and would slightly reduce door-to-door travel time for STOL users, it would be more expensive than the pedestrian tunnel/conveyor system[1], deny use of the Western Gap to at least one-third of the pleasure craft currently transitting the Gap, and restrict all commercial activity to the Eastern Gap, the principal shipping artery.[2]

---

1 CATA has estimated the cost of a fifty-foot bridge at $11 million. The Metro Toronto planning department has also examined the possibility of a vehicle bridge, and have concluded that a forty-foot bridge, combined with a multi-level automobile parking structure (on the Island side), could be constructed for slightly more than $8 million ($3 million for the bridge and $5 million for the parking structure).

2 The consequences of closing the Western Gap to shipping operations have not been thoroughly investigated.

The ISF concept provides for joint use by general aviation at an additional cost of approximately \$2.1 million (\$1.5 million for additional parking spaces and \$0.6 million for the renovation of the existing terminal building and construction of an apron and runway overlay for general aviation aircraft). It has been determined that joint STOL/general aviation use of the airport would be feasible until 1990, at least. Use of the site for either recreational purposes or for housing development would, of course, require the relocation of all general aviation activities at the airport. The closure of Toronto Island Airport would hasten the need for a new general aviation airport in the Toronto area, costing between \$14 and \$28 million, depending on location.

2. ANNUAL COSTS

Annual costs include the cost of operating and maintaining STOLports (O&M costs), salaries for controllers and additional area IFR controllers, and grants to municipalities in lieu of taxes. Those costs are summarized in Table B4 for the two STOLports investigated. It is expected that the additional annual costs required to provide STOL service at conventional airports would be relatively small.

Table B4 Annual STOLport Costs

(thousands of $1976)

	Victoria Carpark (Montreal)	Toronto Island Airport
Airport operations and telecommunications	1035	1220
Air traffic services[1]	370	545
Municipal grants in lieu of taxes	200	1112
Total annual costs	1605	2877

[1] Includes salaries for STOLport controllers and additional area IFR controllers.

Annual municipal taxes, or grants in lieu of taxes, are proxies for the actual additional costs (both capital and operating) which would be incurred by municipalities in support of the development and operation of downtown STOLports in Montreal and Toronto (e.g., improvements in access, traffic control, street lighting, sewer and water, road maintenance, snow removal, etc.). Annual municipal taxes or grants paid to municipalities in lieu of taxes are estimated to equal 2.5% of the combined appraised market value of land and the capital cost of buildings, a percentage suggested by the Municipal Grants Division of the Department of Finance. The appraised land values and capital costs used for this computation are contained in Table B5.

The bases for the appraised values of the Victoria Carpark and Toronto Island STOLport sites are described in the next section.

Table B5 Municipal Taxes or Grants to Municipalities

(thousands of $1976)

	Victoria Carpark (Montreal)	Toronto Island Airport
Capital cost of buildings[1]	4300	4500
Appraised value of land	3700[2]	40000
Total value of land and buildings	8000	44500
Annual municipal taxes or grant (2.5%)	200	1112

1 Includes air terminal building, maintenance garage and control tower ($500,000).

2 Equals estimated value of land after site preparation has been completed.

3. VALUE OF PUBLICLY-OWNED LAND

The land required for the two STOLports examined is either currently owned by, or leased to, the federal government. All but three acres of the Victoria Carpark site is currently owned by NHB; the portion of the Toronto Island Airport site owned by the city of Toronto is on lease to the Toronto Harbours Board at a cost of $1.00 per annum.[1]

The value of publicly-owned land is not included in the computation of the cash costs required to provide the infrastructure necessary for the development of an intercity STOL service. However, the various alternative uses of the land - particularly the Toronto Island site - must be carefully considered when assessing the overall desirability of an intercity STOL system. From a societal point of view, the desirability of STOL depends upon the relationship between the benefits which would result from the development of a STOL system and the resources which would be required to generate those benefits, irrespective of the ownership of those resources. The value of a resource to society is generally assumed to be closely related to its "fair market value", which is related to the benefits which the resource can generate under alternative uses, and which is determined in recognition of restrictions imposed by society on the use of the resource (e.g., zoning) and taxes which would be levied against the owners of the resource to reimburse society for costs resulting from the use of the resource.

A discussion of the land values at the two sites now follows.

---

[1] The existing twenty-one year lease expires in 1983, but contains a renewal clause for a further 21 years, and a stipulation that the City may reacquire the land in the event that it ceases to be used as an airport facility, provided the City were to use it for a park or for aquatic purposes.

Montreal STOLport

Ninety-one of the ninety-four acres of land needed for the Montreal STOLport are owned by NHB; the remaining three acres are owned by CNR and currently have a market value of approximately $300,000. The NHB land is assumed to have no commercial value at the present time, as all commercial uses would require that it first be excavated and filled at a cost of roughly $10/sq. ft., which would be much higher than its subsequent value ($2.25/sq. ft.) under the existing light industrial zoning classification.

Construction of the STOLport would require that approximately 35.9 acres be excavated and filled. Hence, subsequent to the excavation and fill operation, this portion of land, together with the three acres of CNR land acquired, would have a value of approximately $3.7 million.

Toronto STOLport

Two recent appraisals have been made of the portion of Toronto Island which would be required for a STOLport. These appraisals are summarized in Table B6.

Table B6 Appraised Values of Toronto Island STOLport site

Appraisor	CMHC	Public Works
Date of appraisal	February, 1974	August, 1975
Method of appraisal	Market Data	Market Data (esp. recent Crown purchases of water-front land used for Harbourfront Park)
Assumed zoning for appraisal purposes	Low Density Multi-family (1.0 times coverage)[1]	Existing Use (C.1 zoning, which allows airport use)
Appraised unit value	$348,000/acre ($8.00/sq. ft.)	$261,000/ ser-viced acre ($6.00/ serviced sq. ft.)
Gross appraised value (assuming access)	$64,380,000 ($348,000/acre X 185 acres)	$42,582,000 ($261,000/acre X 172 acres, minus $15,000/acre X 154 acres for ser-vicing unserviced land)
Estimated gross Value-Jan. 1976[2]	$77,250,000	$44,350,000
Minus cost of access	$11,500,000	$11,500,000
Estimated value Jan. 1976	$65,750,000	$32,850,000

[1] 1.0 times coverage allows a maximum of one square foot of liveable floor space per square foot of land.

[2] Appraised values are inflated at an annual rate of 10%.

Clearly, the CMHC and Public Works appraisals differ considerably, and no doubt it is because of the different assumptions made concerning alternative uses. The Public Works appraisal is for a C.1 zoning, which allows airport use, but is based largely on prices paid by the federal government for land to be used for recreational purposes. Because of the uniqueness of the site and the lack of market price data for comparable sites, one must recognize that a certain degree of judgement has been exercised in making this appraisal. By contrast, the CMHC appraisal assumes that the site's highest economic use would be low density housing. Under that assumption, CMHC was able to assemble a large volume of comparable market data on which to base an estimate of the market value of the land.[1]

The CMHC estimate may, however, be faulty because of possible access limitations not taken into account in establishing the density of the development. Officials of the Ministry of State for Urban Affairs (MSUA) and the City of Toronto have recently concluded that the Bathurst/Lakeshore intersection would limit a housing development to a density well below 1.0 times coverage. They have derived a value for the site of between $42,700,000 and $47,000,000. This was obtained by subtracting from the (undiscounted) market value of the housing units the total (undiscounted) construction and development costs, including access cost and normal developer's profit.

Although the future of the Toronto Island airport site has not yet been determined, it seems likely that it will either continue to be used as an airport (and/or STOLport), will be used for recreational and/or aquatic purposes, or will be used for housing (neither industrial nor commercial seem likely). Therefore, the market value of the land for housing use represents a minimum value for the site. For purposes of this study, a market value of $40 million has been assumed for the Toronto Island site.

---

1 CMHC also determined that land could be purchased for an alternative general aviation site in the Ajax, Pickering areas for approximately $30,000 - $36,000 per acre ($1976). A site the size of Toronto Island airport would therefore cost approximately $6 million.

4. STOLPORT COST SUMMARY

The STOLport cost estimates developed in the first three Sections are summarized in Tables B7 and B8, for social discount rates of 5%, 10% and 15%. Each of the cost per passenger figures in Table B8 equals the value of the economic benefit (in $1976) which would have to be realized by each STOL passenger during the period 1980-1990 in order for the present value of all such benefits to equal the present value of all costs. These per STOL passenger costs are obtained by dividing the total costs in Table B8 by the corresponding values in Table A8 (Appendix A), which equal present values of a $1.00 benefit realized by all STOL passengers. Economic costs are defined to equal cash costs plus the value of publicly-owned land.

The Two STOLport Option assumes that service would be provided for the seven routes identified in Appendix A. The Single STOLport Option would involve only the five Toronto-based routes of the previous Option, with Montreal service being from Dorval instead of Victoria Carpark.

Table B7 Present Values of Total STOLport Costs

($1976 millions)

5% Discount Rate	Victoria Carpark (Montreal)	Toronto Island Airport
P.V. Capital Cost[1]	30.3	17.7
P.V. Annual Cost[2]	11.1	19.7
P.V. Total Cash Cost	41.4	37.4
P.V. Rent on Owned Land[3]	0.1	20.8
P.V. Total Economic Cost	41.5	58.2
10% Discount Rate		
P.V. Capital Cost[1]	25.8	14.9
P.V. Annual Cost[2]	7.1	12.8
P.V. Total Cash Cost	32.9	27.7
P.V. Rent on Owned Land[3]	0.2	30.4
P.V. Total Economic Cost	33.1	58.1
15% Discount Rate		
P.V. Capital Cost[1]	22.2	12.6
P.V. Annual Cost[2]	4.8	8.6
P.V. Total Cash Cost	27.0	21.2
P.V. Rent on Owned Land[3]	0.2	35.1
P.V. Total Economic Cost	27.2	56.3

---

1 From Table B3.

2 Equals costs per year from Table B4 times $(r^5-r^{16})/(1-r)$, where $r = 1/(1 + \text{discount rate})$. Multipliers are 6.833 at 5%, 4.436 at 10% and 2.992 at 15%.

3 Equals current market value of land times $1-r^{15}$, where r is as defined in footnote 2.

TABLE B8

STOLPORT COST SUMMARY

	STOLport		Options	
	Victoria Carpark (Montreal)	Toronto Island Airport	Two STOLport Option	Single STOLport Option
5% Discount Rate				
P.V. Total Cash Costs	41M	37M	78M	37M
Cash Costs/Passenger[2]	4.10-6.90	3.10-5.20	5.30-9.00	3.60-5.90
P.V. Total Economic Costs	42M	58M	100M	58M
Economic Costs/ Passenger[2]	4.20-7.10	4.80-8.10	6.80-11.50	5.60-9.30
10% Discount Rate				
P.V. Total Cash Costs	33M	28M	61M	28M
Cash Costs/Passenger[2]	5.20-8.80	3.70 -6.20	6.60-18.20	4.30- 7.10
P.V. Total Economic Costs	33M	58M	91M	58M
Economic Costs/ Passenger[2]	5.20-8.80	7.70-12.90	9.80-16.60	8.90-14.70
15% Discount Rate				
P.V. Total Cash Costs	27M	21M	48M	21M
Cash Costs/Passenger[2]	6.40-10.90	4.20- 7.00	7.80-13.30	4.90- 8.10
P.V. Total Economic Costs	27M	56M	83M	56M
Economic Costs/ Passenger[2]	6.40-10.90	11.20-18.90	13.50-22.90	13.10-21.50

[1] Cost per passenger ranges based on numbers of STOLport users, under the Two STOLport Option.

[2] Costs per passenger ranges are for high and low passenger volumes, respectively.

APPENDIX "C": TRANSPORTATION COSTS

APPENDIX "C"

TRANSPORTATION COSTS

This Appendix is concerned with the costs of operating short-haul passenger transport services in general, and a DASH-7 STOL service in the Quebec-Windsor corridor in particular. It is important to identify these costs for two reasons, one relating to the financial feasibility of an intercity STOL system and the other to the economic implications of such a system.

The financial feasibility question is roughly equivalent to asking "Given CTOL fare levels, can the STOL fare be set to a level which will both allow the government to recover a specified portion of the infrastructure costs and also provide the STOL carrier with a reasonable return on investment?" Important to this question is, of course, the monetary value which STOL users would place on the benefits of STOL, and the degree to which the infrastructure costs could and should be recovered from users of the service. This question is important from two different points of view. First, if STOL user charges were made sufficiently large as to make STOL unattractive from a commercial point of view, then there would be little reason to pursue further the question of the economic implications of the system. Secondly, if a decision were made to develop a STOL system in the Quebec-Windsor corridor, for whatever reasons, it would be necessary to determine the degree to which it would be possible to recover infrastructure costs. These issues are taken up in a separate study, but rely heavily on the STOL costs estimates developed in this Appendix.

The question of the economic implications of an intercity STOL system in the Quebec-Windsor corridor is a much broader one, which relates to the alternative uses of the resources which would be necessary to provide an intercity STOL service, in comparison to the direct and indirect benefits which would result. A major portion of these resources would be directly associated with the provision of transportation services, as opposed to the provision of the infrastructure. If a STOL system were developed, certain resources would be required to transport passengers via STOL, but, on the other hand, certain resources associated with CTOL, rail, bus and auto transportation modes would no longer be employed as a result of reduced traffic volumes. This Appendix is concerned with estimating the <u>net change</u> in the value of transportation resources that would be required.

1. AIR CARRIER COSTS

To determine the net change in the value of air transportation resources utilized if STOL were implemented, it is necessary to both estimate the costs of providing DASH-7 services, and to determine the costs which would be avoided by conventional air carriers as a result of passengers being diverted to STOL. The vast majority of these diverted passengers would otherwise have been Air Canada passengers. Consequently, for the purpose of determining the overall reduction in CTOL transportation resources employed, the simplifying assumption has been made that the diversion of CTOL passengers to STOL would be exclusively from Air Canada flights.

The reduced Air Canada passenger volumes on routes served by STOL would result in either a decrease in frequency of flights, or in Air Canada switching to smaller aircraft (e.g., from Boeing 727s to DC-9s), in order to maintain desired levels of frequency. The problem is complicated by Air Canada's huge interlocking route network, and by the fact that each aircraft is assigned a unique route itinerary designed for an aircraft of a specific size. Thus, the impact of STOL would be felt throughout Air Canada's route network, requiring widespread adjustments to flight schedules, aircraft itineraries, fleet planning, etc. In other words, the introduction of STOL would result in a major adjustment of a large part of the airline's operations, and would have a considerable impact on long-term planning.

Thus, the net decrease in Air Canada's revenues and costs would be extremely difficult to determine, even if attempted by the airline itself. Assuming a given level of STOL penetration into Air Canada traffic, the decrease in Air Canada's revenues would no doubt be the less difficult estimate to obtain; however, the impact on the revenue side is not relevant in determining the value of the transportation resources which would be employed with and without STOL.

In estimating the costs which would be avoided by Air Canada, it has been assumed that all CTOL passengers diverted to STOL would be diverted exclusively from flights serviced by DC-9-30 aircraft (all economy, 103 seats). Thus, the capital cost of aircraft, the cost of the flight crew, in-flight crew, maintenance, fuel, etc., have been based upon cost estimates associated with the DC-9-30.

Although Air Canada would no doubt continue to use DC-9s on some of the routes served by STOL, one would expect that larger aircraft could be justified on some of the busier routes. For example, even with a 50% penetration by STOL into Montreal-Toronto origin-destination traffic in 1980, the first year of STOL operation, the total CTOL traffic would be greater than 1975 levels and CTOL origin-destination traffic would be only perhaps 33% less than 1975 levels. Alternatively, if STOL penetration into CTOL was at a lower level, at least during the early 1980s, one could expect CTOL origin-destination traffic to perhaps be at least as great as current levels. Hence it would not be surprising to see Air Canada retain the larger Boeing 727 on that route and perhaps phase in even larger aircraft in the 1980s.

Although cost information for 727s has not been developed, it is believed that, for high density short-haul services, aircraft-related costs <u>per passenger</u> for the DC-9-30 and Boeing 727 would be approximately equal.

A summary of costs incurred in instituting a DASH-7 STOL service, and the costs which Air Canada might be able to avoid, are contained in Tables C1, C2 and C3. The cost estimates associated with STOL are based largely upon cost data developed by Air Canada; the cost figures for the DC-9 operation are in some cases adapted from the STOL data and in other cases have been developed independently, as will be described below.

The costs identified with the DASH-7 STOL operation include all costs to the carrier other than interest charges on debt, charges for airport facilities (e.g., landing fees, terminal charges and aircraft parking fees) and income taxes.[1] DASH-7 flight crew and cabin crew costs are based upon Air Canada wage rates; the labour components of most other STOL costs are based upon wage rates somewhat lower than those prevailing at Air Canada.

A brief description now follows of certain of the cost estimates contained in Tables C1-C3.

---

[1] There may in addition be certain start-up costs (e.g., hiring and training) which would be incurred by the carrier, which have not been included here. However, it is not expected that they would be significant when spread over the entire 1980-1990 planning period. Charges for airport facilities have not been included here because they do not correspond to the cost of the resources which would be employed in providing transportation services. Infrastructure costs have been estimated separately in Appendix B.

Table C1 Aircraft Costs Per Hour, Per Passenger, DASH-7 and DC-9-30 ($1976)

	DASH-7	DC-9-30
Number of seats	50	103
Utilization (hours[1] per year)[2]	2,100	2,520
Costs per aircraft	$4,093,000[3]	$6,990,000[4]
Cost of capital per year[5]		
5% discount rate	464,600	793,400
10% discount rate	608,200	1,038,700
15% discount rate	765,000	1,306,400
Cost of capital per hour		
5% discount rate	221	315
10% discount rate	290	412
15% discount rate	364	518
Cost of capital per hour per passenger[6]		
5% discount rate	$7.37	$5.10
10% discount rate	9.67	6.67
15% discount rate	12.13	8.38

1 Unless otherwise stated, "hours" always means "blockhours".

2 See text, page B8.

3 Based upon Air Canada estimates ($3,745,000 for basic aircraft, $79,000 for spare engines and $269,000 for other spares and inventory), escalated to January, 1976 by CPI.

4 Based upon quoted 1975 base price including 12% federal sales tax, escalated to January, 1976 by CPI (costs of spares included in maintenance costs).

5 Assuming a 10% salvage value after a useful life of 11 years, annual cost of capital equals: (initial capital cost) x $(1-r^n s)$ x $(1-r)$ x $(r-r^{n+1})^{-1}$, where i = fractional discount rate, $r = (1+i)^{-1}$ = discount factor, n = useful life in years, and s = salvage value, as a fraction of initial cost.

6 Assuming a 60% load factor.

Table C2 Unit Carrier Operating
Costs, Excluding Cost of Aircraft, DASH-7 and DC-9-30[1]

($1976)

	DASH-7		DC-9-30	
Number of seats	50		103	
Costs per hour				
hull insurance[2]	36		47	
flight crew	95		123	
cabin crew	45		79	
flight maintenance - per hour	102		102	
fuel cost - per hour	120		405	
misc. flying expenses	10		12	
SUBTOTAL	408		768	
Total costs per hour per passenger[3]		13.60		12.43
Costs per passenger				
food and supplies	.88		.88	
passenger liability insurance	.58		.58	
promotion and sales	2.75		2.75	
advertising and publicity	.54		.54	
variable administration	.26		.26	
carrier fixed costs[4]	2.97		2.97	
SUBTOTAL	7.98		7.98	
Total cost per passenger		12.91		13.69

[1] Not including non-aircraft capital costs and fixed portions of administration costs.

[2] Estimated to be 2% of initial aircraft cost divided by estimated annual aircraft utilization (from Table C1).

[3] Assuming a 60% load factor.

[4] From Table C3.

Table C3 STOL Carriers' Fixed Costs
(Thousands of $1976)

Capital Cost

Maintenance base, Toronto	7,100	
Line maintenance facility, Montreal	3,100	
Ground equipment and tooling	1,020	
Head office building, offices, furniture and equipment	850	
Total[1]		12,070

Annual Fixed Administrative Cost

Flight crew, supervisory	293	
In-flight crew, supervisory	56	
Servicing administration	260	
Promotion and sales organization	231	
General administration organization	1,261	
Total per year		2,101

Present Value of Fixed Costs

	Discount Rate 5%	10%	15%
P.V. capital cost[2]	7,662	7,755	7,291
P.V. fixed annual cost[3]	14,358	9,320	6,290
P.V. total fixed cost	22,020	17,075	13,581

Average Cost per STOL Passenger[4]

	Two STOLport Option		Single STOLport Option	
	high volume	low volume	high volume	low volume
5% discount rate	1.49	2.54	2.14	3.53
10% discount rate	1.83	3.11	2.62	4.32
15% discount rate	2.21	3.75	3.17	5.22

Represenitive Cost Per STOL Passenger = $2.97.[5]

---

1 All capital costs are assumed to occur at the beginning of 1979. Working capital (estimated at $3M) has not been included here because it does not represent an economic cost in terms of the utilization of resources.

2 Assumed 50% physical depreciation after 11 years. Equals total capital cost multiplied by $(r^3 - (.5)r^{14})$, where $r = (1+i)^{-1}$ and i equals the appropriate discount rate.

3 Equals annual cost multiplied by $(r^5 - r^{16})/(1 - r)$, where r is as in footnote 2.

4 Equals present value of fixed costs divided by appropriate value from Table A8, Appendix A.

5 See page C-16 of text for explanation.

Aircraft Utilization

The relatively low utilization of the DASH-7 is due to the nature of the service being provided, in that there would be little evening and weekend traffic, and only limited mid-day demand. The figure of 2,100 hours may in fact be somewhat high, in that it has been obtained from a simulation which was based in part on the assumption that the same proportion of weekday traffic serviced by Airtransit during their 2 1/2 hour morning peak period could be serviced by a DASH-7 STOL carrier in a 3-hour morning peak period. To increase aircraft utilization, it would be necessary to decrease fleet size and therefore leave a portion of peak period demand unsatisfied.

The DC-9-30 utilization figure of 2,520 revenue hours per year was extrapolated from actual average aircraft utilizations achieved by Air Canada, CP Air and the regional airlines in 1975. Figure C1 depicts average aircraft utilization as functions of average stagelength, for Air Canada's 727, DC-9-15 and DC-9-30 fleets, for CP Air's 737 fleet and for each of the regional airlines' 737 fleets.[1,2] Using the passenger forecasts developed in Appendix A, the average stagelength of CTOL flights which would be avoided by having STOL was found to be approximately 270 miles (264 miles for the Two STOLport Option; 272 miles for the Single STOLport Option). Applying this figure to the assumed straight-line relationship superimposed on Figure C1, the appropriate CTOL utilization is estimated to be 2,520 revenue hours per year.

Cost of Aircraft

The figure quoted for the DC-9 is the cost of new equipment. To the extent that a diversion of traffic to STOL would result in a reduction in Air Canada's existing short-haul fleet, as opposed to a reduced level of new aircraft acquisition, the price of the DC-9 may overestimate the value of the aircraft resources no longer employed by Air Canada.

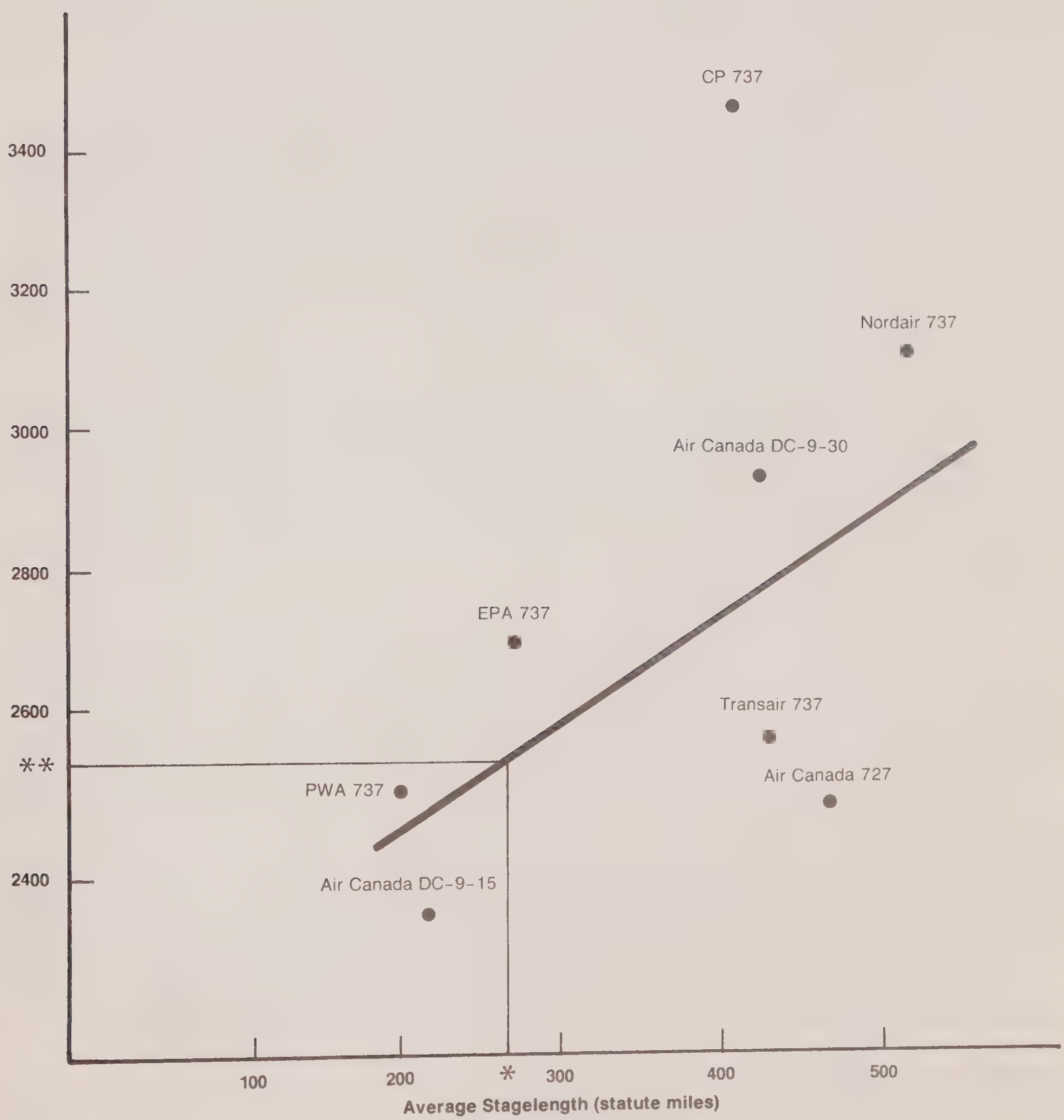
---

1 Source: Aviation Statistics Centre, Statistics Canada.

2 An Air Canada official reports that 727 utilization has improved significantly in 1976, due to increased fleet size and also because their 727 aircraft are increasingly used for weekend charter operations to Florida and the Caribbean.

Figure C1

AVERAGE AIRCRAFT UTILIZATION VERSUS AVERAGE STAGELENGTH (1975 data)



* Average stagelength of avoided CTOL flights (272 miles).

** Assumed average annual aircraft utilisation of avoided CTOL flights (2520 hours/year).

Cost of Capital-Aircraft

The assumption that both the DASH-7 and DC-9 would depreciate to 10% of their initial value after eleven years may underestimate the period over which they could be productively employed. However, the difference between the annual cost of capital of the two aircraft would not change appreciably by extending the useful life of both aircraft.

Flight Crew

The flight crew costs for the DASH-7 are based upon the formula which was used for determining pay for Air Canada's Viscount captains and first officers (with three years service).[1] The cost per hour assumes a productivity of 73% (.73 hours flown for each hour paid), and includes a 16% fringe benefit allowance and an allowance for crew cycle and personal expenses. The comparable cost at regional carrier rates is approximately $75 per blockhour, or 20% less than Air Canada costs.

The flight crew costs for the DC-9 are based on Air Canada's pay scale, assume a productivity of 73% and include allowances for fringe benefits and personal expenses. The comparable cost to a regional airline is approximately $95 per blockhour, or 23% less than Air Canada costs.

In-Flight Crew

The in-flight crew costs for the DASH-7 (two flight attendants) are also based upon Air Canada pay rates, assume a 73% productivity factor and include a 16% fringe benefit allowance and an allowance for crew cycle and personal expenses. The comparable in-flight crew cost at regional airline rates is approximately $40 per blockhour, or 12% less than Air Canada costs.

In-flight crew costs for the DC-9 are based upon an average of 3 1/2 flight attendants per flight, and assume the same cost per flight attendant as for the DASH-7, at Air Canada wage rates. The comparable cost to a regional airline is approximately $70 per blockhour, or 12% less than Air Canada costs.

---

[1] The formula cost per blockhour is a function of aircraft weight and speed.

Maintenance Cost

The maintenance cost estimate developed by Air Canada for the DASH-7 was compared to an estimate obtained by applying general cost formulae developed by de Havilland.[1] The Air Canada estimate, which was obtained through an independent detailed analysis of maintenance requirements, was found to be only 11% lower than one obtained from the de Havilland cost formulae. Because the Air Canada estimate was developed for a specific mix of routes, however, it was decided to convert it from a total (or cost per hour) basis to a cost per departure/cost per hour basis, using the relationship between per hour and per departure costs which had been developed by de Havilland.

Maintenance cost for the DC-9-30 was developed from a cost estimating formula developed by Boeing Aircraft in 1973, adjusted to 1976 dollars.

Fuel Costs

DASH-7 fuel cost was first calculated on a per route basis and then translated to a per departure/per hour basis.[2] DC-9 fuel consumption was initially estimated to be 134 imp. gals. per departure plus 2.533 imp. gals. per mile and then adjusted to comparable per departure/per hour levels. Fuel cost for the period 1980-1990 (in $1976) was set at an arbitrary level of $.70 per imperial gallon, as compared to the May 1975 price of $.43 per imperial gallon.[3]

---

1 The de Havilland maintenance cost estimate is based upon formulae they have developed which are functions of total numbers of flights, total flight hours and maintenance labour cost per hour.

2 Fuel consumption estimates (as well as blocktime) were extraplolated from detailed analyses done by Air Canada of the Montreal-Toronto, Montreal-Ottawa and Toronto-Ottawa routes, considering such things as prevailing winds, probable area navigation profiles, fuel load, etc.

3 An indicaticn of the sensitivity of operating costs to the cost of energy are discussed in Section 4 of Appendix D.

Miscellaneous Flying Expenses

The Air Canada cost estimates for the DASH-7 STOL operation included a contingency of 10% of flight crew labour costs, which when added to miscellaneous insurance costs equals approximately 10% of total flight crew cost. The same percentage has been used in calculating the value of miscellaneous DC-9 flying expenses which would be avoided.

Ground Equipment Maintenance

Ground equipment costs for the DASH-7 are based upon Air Canada cost estimates. Cost estimates for the DC-9 are obtained by multiplying the DASH-7 cost estimate by the ratio of the DC-9 ground equipment maintenance cost estimate obtained by the Boeing cost formula, to the DASH-7 cost estimate obtained by the same formula.

Aircraft and Traffic Servicing

DASH-7 aircraft and traffic servicing costs are based upon Air Canada cost estimates ($33 per departure for aircraft servicing and $21 per departure for traffic servicing).[1] DC-9 cost estimates for each of these two items were extrapolated from the DASH-7 estimates on the basis of the Boeing cost formula, using the same procedure as employed in estimating DC-9 ground equipment maintenance costs. (DC-9 costs are estimated to be $86 per departure for aircraft servicing and $43 per departure for traffic servicing.)

Per Passenger Costs

The variable costs directly related to servicing STOL passengers are not expected to be significantly different than the costs of the same passenger-related services that Air Canada could avoid by not servicing short-

---

1 Exclusive of servicing administration costs, which are treated as fixed annual carrier costs (Table C3), and terminal charges and STCLmobile costs, which are not included here as carrier costs.

haul CTOL passengers.[1] Hence, the STOL cost figures, which are based upon Air Canada cost estimates, have been used for both STOL and CTOL services.

Fixed Annual Costs

The capital cost requirements in Table C3 are extrapolated from estimates developed by Air Canada for a significantly smaller DASH-7 STOL operation than contemplated here. Based upon a fleet of 14 DASH-7 aircraft, the Air Canada estimates for the main maintenance base, the line maintenance facility, and ground equipment and tooling are \$4.5, \$2.0 and \$.7 million respectively. By contrast, for the STOL passenger forecasts developed in this study a fleet of between 23 and 36 DASH-7s would be needed by 1985.[2]

While it could be expected that the capital cost requirements for the two maintenance facilities and for ground equipment and tooling would be less than proportional to fleet size, the precise relationship between cost and fleet size is not known. The cost estimates in Table C3 are based upon an assumed 1985 fleet size of 30 DASH-7s, and are calculated using the following formula:

Cost for 30 A/C fleet = cost for 14 A/C fleet +
(30-14)x(1/2)x(cost for 14 A/C fleet)/14.

In other words, it is assumed that for each additional aircraft beyond the first 14, the capital costs for the two maintenance bases and for ground equipment and tooling increase at a rate of one-half of the average capital cost per aircraft as estimated by Air Canada for a fleet size of 14 aircraft.

---

1 The promotion and sales costs include only variable costs; managerial and other fixed costs associated with promotion and sales activities are included in annual fixed costs.

2 The DASH-7 fleet, which is assumed to include three spare aircraft, could be expected to increase to between 29 and 48 aircraft by 1990.

It is further assumed that the Air Canada estimates of capital requirements for office buildings and furnishings, and the Air Canada estimate of the fixed component of the annual administration costs would also apply, without increase, to the expanded STOL operations considered here.

Although the estimates of capital cost requirements developed above are quite rough, they are not expected to introduce a significant amount of error into the analysis. In particular, the total cost per passenger figures in Table C2 are only 20¢ to 40¢ greater than they would be if the Air Canada estimates (which are based upon a 14 aircraft fleet) were not increased whatsoever to account for the larger fleet size. Hence, it can be expected that any overestimate of these costs would be quite small. Similarly, this estimate would not be expected to understimate the actual cost by more than 20¢ - 40¢ per passenger, which is roughly the cost increase required if the capital cost as a function of fleet size were to exhibit no economies of scale.

To this point, estimates have been developed for the costs of all resources directly employed in the provision of a DASH-7 STOL service. Also, estimates have been made of the costs that Air Canada would avoid because of reduced passenger traffic. In addition to those costs identified with a DC-9-30 CTOL service in Table C2, one would expect that it would be possible for Air Canada to reduce the level of their capital expenditure and/or administrative overhead expense as a result of the diversion of CTOL traffic to STOL. Unfortunately, no estimates are available of the possible savings in this area. In view of the cost items already identified in Table C3, and the fact that as a function of fleet size, passengers flown, etc., there are economies of scale in the areas of non-aircraft capital expenditure and administrative overhead, it is doubtful that in these two areas Air Canada would save more than a STOL carrier would spend, on a per passenger basis. It is assumed here that, on a per passenger basis, Air Canada (and other CTOL carriers) would reduce non-aircraft capital costs and annual administrative costs (in addition to those already identified in Table C2) by amounts equivalent to those identified as costs for a DASH-7 STOL operation (Table C3), although it is felt that this tends to overestimate the savings which Air Canada might in fact realize.

To simplify the calculation, a single fixed cost per passenger figure of $2.97 per passenger has been used for both STOL system options and for all three interest rates examined.[1] It can be shown that this simplifying assumption introduces very little error into the analysis.[2]

---

1 The figure $2.97 is the average of the four cost per passenger figures from Table C3 which correspond to the 10% discount rate (i.e., the average of $1.83, $3.11, $2.62 and $4.32).

2 It can be shown that the above simplifying assumption introduces a maximum error in economic net benefit of 36¢ per passenger, and that occurs with the Two STOLport Option, high volume scenario, 5% discount rate.

The total carrier costs incurred by STOL and avoided by CTOL, on a per departure per passenger basis, assuming the high STOL penetration scenario and a 10% discount rate, are summarized in Table C4.[1] The differences between STOL and CTOL operating costs for the low STOL penetration scenario are approximately the same as those for the high penetration scenario.

The STOL and CTOL costs per passenger, for each route and averaged over all routes, assuming a 10% discount rate, are summarized in Table C5. The sensitivity of the average costs per passenger to the discount rate adopted is displayed in Table C6.

Table C4
Total Economic Costs Per Passenger
Incurred by STOL Carrier and Avoided by CTOL Carriers

($1976)

	STOL (DASH-7)	CTOL (DC-9-30)
Cost Per Hour		
5% discount rate	20.97	17.53
10% discount rate	23.27	19.10
15% discount rate	25.73	20.81
Cost Per Departure	12.91	13.69

[1] Observe that because the DASH-7 and DC-9-30 do not fly at the same speed it is not possible to calculate the net savings of CTOL over STOL by simply computing the differences between their respective unit costs.

Table C5

Total STOL and CTOL Carrier Costs
Per Passenger, by Route
(10% discount rate, $1976)

Route	%Total Passengers from CTOL: Two STOLport Option (%)	%Total Passengers from CTOL: Single STOLport Option (%)	Blocktime (hrs.) STOL	Blocktime (hrs.) CTOL	Costs Per Passenger STOL	Costs Per Passenger CTOL	Costs Per Passenger STOL-CTOL
Montreal-Toronto	59	60	1.46	1.05	46.88	33.75	13.13
Montreal-Ottawa	6	0	.67	.50	28.50	23.24	5.26
Montreal-Quebec	4	0	.84	.67	32.46	26.49	5.97
Toronto-Ottawa	20	25	1.13	.88	39.21	30.50	8.71
Toronto-London	1	3	.64	.58	27.80	24.77	3.03
Toronto-Windsor	3	3	1.02	.75	36.65	28.02	8.63
Toronto-Sudbury	7	9	1.08	.78	38.04	28.59	9.45
Route Weighted Average Two STOLport Option			1.274	.935	42.54	31.56	10.98
Route Weighted Average Single STOLport Option			1.306	.960	43.29	32.03	11.26

Table C6

Total STOL and CTOL Carrier Costs
Per Passenger[1]

	STOL	CTOL	STOL-CTOL
Two STOLport Option			
5% discount rate	39.63	30.08	9.55
10% discount rate	42.54	31.56	10.98
15% discount rate	45.69	33.15	12.54
Single STOLport Option			
5% discount rate	40.30	30.52	9.78
10% discount rate	43.29	32.03	11.26
15% discount rate	46.51	33.67	12.84

1 Weighted Average over all routes.

The estimates of avoidable CTOL costs adopted in this study may be compared with cost estimates obtained from the application of an Air Canada cost formula which relates system-wide, fully allocated costs per passenger to stagelength, for non-stop flights. Adjusted to January, 1976 dollars, Air Canada estimates its fully allocated cost per passenger to be $25.84 plus 5.14¢ per mile.

Although this formula may provide a good estimate of long-term, system-wide <u>average</u> costs, it would undoubtedly <u>overestimate</u> the long-term <u>marginal</u> costs associated with the short-haul air traffic which would be diverted to STOL.

A senior Air Canada official is of the view that for each CTOL passenger diverted to STOL, Air Canada's total costs might be decreased by as much as 90% of fully allocated average costs (from the cost formula), provided STOL and CTOL services were operated in a cooperative way. If the Air Canada cost formula is applied to each of the proposed STOL routes and the resulting cost estimates are multiplied by .9, and then averaged -- using the (route) weights contained in Table C5 -- average avoidable CTOL cost would be $35.49 for the Two STOLport Option and $35.88 for the Single STOLport Option. These estimates are approximately 12% higher than the average avoidable CTOL costs contained in Table C5 ($31.56 and $32.03, for the two STOL options, respectively).

On balance, the cost estimates developed for the DASH-7 STOL operation are expected to be reasonably accurate, whereas the estimates of the costs which would be avoided by CTOL carriers -- principally Air Canada -- are subject to a greater potential error.

2. <u>COST SAVINGS FOR SURFACE MODES</u>

Cost savings resulting from a diversion of traffic to STOL from the three surface modes -- rail, bus and auto -- are discussed below.

Marginal Rail Costs

The marginal rail costs of interest are those which correspond to the reduction in the value of resources which could be achieved by the rail carriers if the projected volume of rail passengers were diverted to STOL.[1] Upon advice of the Systems Analysis Branch of the CTC, the avoidable rail costs were calculated in the following manner. For those routes with annual (one-way) passenger volumes below 7,500, it was assumed that the number of diverted passengers would not be significant enough to warrant the removal of a rail car, in which case the cost savings were taken to be zero. Where annual passenger volumes were between 7,500 and 100,000, it was assumed that one or more rail cars could be removed at a cost savings of 3.0¢ per passenger-mile. On routes with passenger volumes in excess of 100,000, it was assumed that an entire train set could be removed, at a cost savings of 8.0¢ per passenger-mile.[2] Using this method, a cost savings of 3.0¢ was assigned to each of the routes served by STOL.

Marginal Bus Costs

It is assumed that all costs of providing intercity bus service are, in the long-run, direct costs, proportional to the number of passengers transported on any given route. Further, it is assumed that costs vary in proportion to distance, and that the fare charged is roughly equal to all costs incurred by the operator. A Treasury Board study estimated average 1974 total operating costs to be 3.6¢ per passenger mile. This cost compared reasonably well to a cost of 3.0¢ per passenger-mile determined by analysts at Transport Canada using a direct costing approach (no infrastructure included). The 3.6¢ figure has been adopted for use here. When inflated to January 1976, the amount becomes 4.4¢ per passenger mile.

---

1 This cost is not to be confused with either increases in operating subsidies or the allocation of joint infrastructure costs, both of which are unrelated to resources utilization.

2 If the reduction in rail passenger traffic were sufficiently large as to provide the impetus for discontinuing unprofitable rail lines, a larger benefit might be counted. The reduction in traffic due to STOL, however, is not expected to be of such a magnitude that this would be likely.

Marginal Automobile Costs

In calculating the value of automobile resources conserved through reduced use as a result of STOL, several problems arise. The most significant one is identifying which costs are variable and which are not. Here it has been assumed that all costs other than licensing are variable. Surely fuel, oil and maintenance are variable, and depreciation (in the form of cost of capital) would seem to be a relevant cost, assuming that reduced use of an automobile would extend its useful life. Finally, one might assume that the expected additional costs resulting from accidents would be reflected in a proportional part of insurance premiums.

In addition to these costs, the reduction in intercity auto traffic would perhaps reduce slightly the cost of road maintenance, reduce or delay the cost of additional infrastructure, and reduce injuries and loss of life. The value of these additional benefits, net of the marginal payments made by the user in the form of gasoline taxes, is not known and has not been accounted for in this analysis.

The avoidable automobile costs, in January 1976 dollars, are summarized in Table C7.

Table C7 Avoidable Automobile Costs[1]

($1976)

Item	¢/Passenger-Mile
Cost of Capital[2]	5.0
Fuel and oil[3]	3.8
Maintenance Cost[4]	4.6
Insurance[5]	1.5
Total Cost/Passenger-Mile	14.9¢

---

1 Based on 1.3 passengers per trip, 10,000 miles/year.

2 Price (incl. tax): $4,600, 10% discount rate, 9 years, 10% salvage value.

2 Fuel: 25 miles/gallon @ $1.25/gallon, oil: 1.4 qts./1000 miles @ $2.00/qt.

4 $600/year for maintenance, repairs and replacement parts.

5 $200/year.

The avoidable costs per passenger for bus, auto, and rail for the seven routes examined in this study, are contained in Table C8.

Table C8 Avoidable Costs per Passenger, Bus, Rail and Auto

Route	No. of statute road miles	No. of statute rail miles	Bus costs[1]	Auto costs[2]	Rail costs[3]
Montreal-Toronto	350	335	15.40	52.15	10.05
Montreal-Ottawa	120	116	5.28	17.88	3.48
Montreal-Quebec	163	167	7.17	24.29	5.01
Toronto-Ottawa	250	277	11.00	37.25	8.31
Toronto-London	120	115	5.28	17.88	3.45
Toronto-Windsor	235	223	10.34	35.02	6.69
Toronto-Sudbury	251	272	11.04	37.40	8.16

[1] 4.4¢ per passenger road-mile.

[2] 14.9¢ per passenger road-mile.

[3] 3.0¢ per passenger rail-mile.

3. COST SUMMARY

The per passenger costs incurred for STOL and avoided for CTOL, rail, bus and auto are summarized by route in Table C9. Table C9 also contains the average avoidable costs per passenger over all non-STOL modes, using the appropriate weights from Table C10.

Table C9

Average Avoidable Intercity Transportation Costs per Passenger, by Route and Mode[1]
(10% discount rate, $1976)

Route	CTOL	Rail	Bus	Auto	Average w/o STOL[2]	STOL	Net Cost Increase with STOL
Montreal-Toronto	33.75	10.05	15.40	52.15	32.82/32.93[3]	46.88	14.06/13.95[3]
Montreal-Ottawa	23.24	3.48	5.28	17.88	15.29	28.50	13.21
Montreal-Quebec	26.49	5.01	7.17	24.29	19.32	32.46	13.14
Toronto-Ottawa	30.50	8.31	11.00	37.25	30.26	39.21	8.95
Toronto-London	24.77	3.45	5.28	17.88	12.63	27.80	15.17
Toronto-Windsor	28.02	6.69	10.34	35.02	21.01	36.65	15.64
Toronto-Sudbury	28.59	8.16	11.04	37.40	27.13	38.04	10.91

Table C10

Source of STOL Passengers, by Route, in Percentage Terms

Route	Percentage of Total STOL Demand by Route: Two STOLport Option	Single STOLport Option	STOL Passenger Source: CTOL	Rail	Bus	Auto
Montreal-Toronto	50	0	89	7	0	4
Dorval-Toronto	0	55	93	5	0	2
Montreal-Ottawa	12	0	35	10	24	31
Montreal-Quebec	6	0	49	18	15	18
Toronto-Ottawa	16	22	95	2	0	3
Toronto-London	5	8	29	38	14	19
Toronto-Windsor	5	6	59	34	1	6
Toronto-Sudbury	6	9	87	8	1	4
Route Weighted Averages						
Two STOLport Option			76	10	5	9
Single STOLport Option			86	9	1	4

[1] Costs incurred by STOL and avoided by other modes.

[2] Modal weights from Table C10.

[3] Montreal STOLport/Dorval.

Table C11

Total Average Trip Costs Per Passenger (10% discount rate, $1976)

Route	Percentage of total STOL Demand by Route: Two STOLport Option	Single STOLport Option	Intercity Cost[1]: STOL	W/O STOL	Access/Egress Cost[2]: STOL	W/O STOL	Total Trip Cost: STOL	W/O STOL	Net Cost with STOL
Montreal-Toronto	50	0	46.88	32.82	2.98	7.09	49.86	39.91	9.95
Dorval-Toronto	0	55	46.88	32.93	5.36	7.33	52.24	40.26	11.98
Montreal-Ottawa	12	0	28.50	15.29	4.80	3.22	33.30	18.51	14.79
Montreal-Quebec	6	0	32.46	19.32	3.85	3.72	36.31	23.04	13.27
Toronto-Ottawa	16	22	39.21	30.26	4.88	6.93	44.09	37.19	6.90
Toronto-London	5	8	27.80	12.63	3.93	3.21	31.73	15.84	15.89
Toronto-Windsor	5	6	36.65	21.01	3.93	4.71	40.58	25.72	14.86
Toronto-Sudbury	6	9	38.04	27.13	3.93	5.72	41.97	32.85	9.12
Route Weighted Averages									
Two STOLport Option			40.58	27.56	3.71	6.00	44.29	33.56	10.73
Single STOLport Option			42.25	29.48	4.93	6.61	47.18	36.09	11.09

[1] From Table C9.

[2] From Table D8 in Appendix D.

A summary of total trip costs, over all routes and for each of the two STOL options, assuming a 10% discount rate, is contained in Table C11. Average access/egress costs by route, which are added to average (avoidable) intercity costs per route to obtain total average trip costs, are derived in Section 2 of Appendix D.[1] The overall conclusion is that for the Two STOLport Option (STOLports in Montreal and Toronto serving seven domestic routes) STOL costs would exceed non-STOL savings (i.e., avoided costs) by approximately $13.02 per STOL passenger for the intercity portion of the trip and STOL would result in a net savings of $2.29 on access/egress costs. Hence, STOL would result in an overall net increase in transportation resource costs of $10.73 per passenger. For the Single STOLport Option (the Toronto STOLport only, serving five routes, including Toronto-Dorval) the results are essentially the same, with STOL resulting in an overall increase in costs of $11.09 per passenger.

The sensitivity of the net increased transportation cost of STOL over other modes, as a function of the discount rate adopted, is displayed in Table C12. The present values of <u>total</u> increased transportation costs, over the period 1980-1990, are given in Table C13, as a function of the discount rate adopted. These values are obtained by multiplying the entries in Table C12 by the corresponding values in Table A8 (Appendix A).

---

1 More precisely, the average trip costs are average marginal trip costs per passenger, or average avoidable costs per passenger.

Table C12

Net Increased Transportation Costs of STOL over Other Modes, Per STOL Passenger, as a Function of Disccunt Rate (Route Weighted Average)

($1976)

	Discount Rate		
	5%	10%[1]	15%
Route Weighted Averages			
Two STOLport Option	9.11	10.73	12.44
Single STOLport Option	9.44	11.09	12.82

Table C13

Present Values of Total Increased Transportaticn Costs of STOL Cver Other Modes, for 1980-1990 Planning Period, as a Function of Discount Rate

(millions of $1976)

	Discount Rate		
	5%	10%	15%
Two STOLport Option			
high STOL volume	134	100	76
low STOL volume	79	59	45
Single STOLport Option			
high STOL volume	97	72	55
low STOL volume	59	43	33

---

[1] Values corresponding to the 10% discount rate are from Table C11.

APPENDIX "D": STOL BENEFITS

APPENDIX "D"

STOL BENEFITS

This Appendix is concerned with the examination of three potential transportation benefits which would likely result from the adoption of an intercity STOL system:

(1) time savings for STOL users;
(2) access/egress cost savings for STOL users; and
(3) reductions in delays and congestion at CTOL airports and postponement of the construction of new CTOL airport facilities.

In addition, the impact of the STOL system on energy consumption is assessed.

1. TRIP TIME SAVINGS

One of the largest benefits resulting from an intercity STOL system would be the total trip time savings which would accrue to users of the service. Total (one-way) trip time, in going from city A to city B, may be conveniently thought of as having three components: access/egress time, terminal time, and blocktime. Access time is the time required to get from the point of trip origin in city A to the carrier terminal facility in city A (by foot, private automobile, taxi, public transit, etc.). Egress time is the time required to get from the terminal facility in city B to the point of destination in city B. Access/egress time is the sum of the individual access and egress times. Terminal time is the time elapsed between arriving at the terminal in city A and departing by common carrier for city B, plus the time elapsed between arrival in city B and departure from the terminal in city B.[1] Blocktime is the time spent travelling from the terminal in city A to the terminal in city B.

In comparison with CTOL, STOL results in decreased average access/egress and terminal times, but in increased blocktimes. STOL offers total trip time savings for distances of up to approximately 400 miles for routes having "downtown" STOLports at both ends. For routes with STOLports at only one end STOL results in time savings for routes up to about 300 miles.

---

[1] For automobile travel, both access/egress and terminal times are zero (i.e., total trip time equals blocktime).

STOL offers only slight terminal time savings over rail and bus, which generally both have downtown terminal locations, but blocktime savings with CTOL increase rapidly with distance. Similarly, the trip time savings of STOL over auto are modest for short distances but quite large for longer routes.

Average access/egress times, terminal times, blocktimes and total trip times are provided for each of the seven STOL routes considered in this study, and for each mode, in Table D1 (plus Dorval-Toronto). Overall average time savings (weighted by mode) are calculated in Table D2 for the two STOL system options. Table D3 contains a comparison of STOL and CTOL trip times. Data on which access/egress and terminal times are based are contained in Tables D4 and D5.

From Tables D2 and D3 one may conclude that for the Two STOLport Option, STOL would result in an overall average trip time saving of 39 minutes, with those STOL passengers diverted from CTOL saving an average of 15 minutes.[1] For the Single STOLport Option the average time savings for STOL passengers would be significantly less -- 22 minutes overall and only 2 minutes for passengers diverted from CTOL.

A brief description of the derivation of each of the three trip time components now follows.

<u>Access/Egress Times and Costs</u>[2]

Access/egress times for Toronto, Montreal and Ottawa are based upon the results of a questionnaire administered by the CTC in the summer of 1969 for the purpose of obtaining various data from CTOL, rail and bus users for their 1970 Intercity Passenger Transport Study. Respondents were asked, among other things, their points of trip origin and destination, their city of residence, their mode of access from trip origin to the common carrier terminal, their

---

[1] These time savings assume that domestic short-haul CTOL flights would continue to use Dorval Airport throughout the 1980s. If domestic short-haul flights were transferred to Mirabel, average time savings, over all STOL passengers and all routes, would increase by perhaps 15-20 minutes.

[2] Although access/egress costs are not summarized in this section, it is logical to describe the procedure by which they were calculated at this point.

access time and access cost, and the purpose of their trip.[1] On the basis of the survey information, perceived average access/egress times and costs (the latter adjusted to 1976 dollars) were developed for short-haul passengers travelling by CTOL, rail and bus, for Montreal, Toronto, Ottawa and a representative "other" city.[2]

---

1 Average access/egress times and costs for each city were based upon access times and costs as reported by both residents and non-residents of the city.

2 Michael F. Shaw and Eric K. Culley, Urban Access in the Canadian Corridor, Canadian Transport Commission Report 32, June, 1972.

Table D1, Total One-Way Trip Time, (minutes) by Mode and Route

Montreal-Toronto

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	89	52	50	63	165
RAIL	7	31	39	300	370
BUS	0	33	36	370	439
AUTO	4	0	0	350	350
Weighted average w/o STOL		49	47	91	187
STOL		28	30	88	146

Montreal-Ottawa

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	35	51	45	30	126
RAIL	10	29	36	120	185
BUS	24	26	28	134	188
AUTO	31	0	0	130	130
Weighted average w/o STOL		27	26	95	148
STOL		40	35	40	115

Montreal-Quebec City

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	49	45	37	40	122
RAIL	18	27	30	180	237
BUS	15	24	25	160	209
AUTO	18	0	0	178	178
Weighted average w/c STOL		31	27	108	166
STOL		34	27	50	111

Toronto-Ottawa

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	95	53	45	53	151
RAIL	2	30	35	300	365
BUS	0	35	34	285	354
AUTO	3	0	0	273	273
Weighted average w/o STOL		51	43	65	159
STOL		40	35	68	143

Toronto-London

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	29	47	37	35	119
RAIL	38	28	29	120	177
BUS	14	33	31	140	204
AUTO	19	0	0	131	131
Weighted average w/o STOL		29	26	100	155
STOL		34	27	38	99

Toronto-Windsor

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	59	47	37	45	129
RAIL	34	28	29	235	292
BUS	1	33	31	295	359
AUTO	6	0	0	257	257
Weighted average w/o STOL		38	32	125	195
STOL	25	34	27	61	122

Toronto-Sudbury

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	87	47	37	47	131
RAIL	8	28	29	360	417
BUS	1	33	31	325	389
AUTO	4	0	0	274	274
Weighted average w/o STOL		43	35	84	162
STOL		34	27	64	125

Dorval-Toronto

Source of STOL Demand	% of STOL Demand	Access/Egress	Trip Time Terminal	Block	Total
CTOL	93	52	50	63	165
RAIL	5	31	39	300	370
BUS	0	33	36	370	439
AUTO	2	0	0	350	350
Weighted average w/c STOL		50	48	81	179
STOL		39	40	88	167

Table D2, Total One-Way Trip Time Savings With and Without STOL[1]

(minutes)

Route	% of STOL passengers Two STOL-ports	Single STOLport	Access/Egress Time STOL	w/o STOL	Terminal Time STOL	w/o STOL	Block Time STOL	w/o STOL	Trip Time STOL	w/o STOL	STOL Savings
Montreal-Toronto	50	0	28	49	30	47	88	91	146	187	41
Dorval-Toronto	0	55	39	50	40	48	88	81	167	179	12
Montreal-Ottawa	12	0	40	27	35	26	40	95	115	148	33
Montreal-Quebec	6	0	34	31	27	27	50	108	111	166	55
Toronto-Ottawa	16	22	40	51	35	43	68	65	143	159	16
Toronto-London	5	8	34	29	27	26	38	100	99	155	56
Toronto-Windsor	5	6	34	38	27	32	61	125	122	195	73
Toronto-Sudbury	6	9	34	43	27	35	64	84	125	162	37
Route Weighted Average											
Two STOLport Option			33	44	31	40	71	90	135	174	39
Single STOLport Option			38	47	36	43	76	82	150	172	22

[1] Access/egress, terminal and blocktimes without STOL are weighted averages from Table D1.

Table D3, Total One-Way Trip Time Savings of STOL Compared to CTOL[1]

(minutes)

Route	% of STOL passengers Two STOL-ports	Single STOLport	Access/Egress Time STOL	CTOL	Terminal Time STOL	CTOL	Block Time STOL	CTOL	Trip Time STOL	CTOL	STOL Savings
Montreal-Toronto	59	0	28	52	30	50	88	63	146	165	19
Dorval-Toronto	0	60	39	52	40	50	88	63	167	165	-2
Montreal-Ottawa	6	0	40	51	35	45	40	30	115	126	11
Montreal-Quebec	4	0	34	45	27	37	50	40	111	122	11
Toronto-Ottawa	20	25	40	53	35	45	68	53	143	151	8
Toronto-London	1	3	34	47	27	37	38	35	99	119	20
Toronto-Windsor	3	3	34	47	27	37	61	45	122	129	7
Toronto-Sudbury	7	9	34	47	27	37	64	47	125	131	6
Route Weighted Average											
Two STOLport Option			31	51	31	46	77	57	139	154	15
Single STOLport Option			38	51	37	47	79	58	154	156	2

[1] Access/egress, terminal and blocktimes without STOL are weighted averages from Table D1.

Table D4, Average Access/Egress Times
(minutes)

MODE	TORONTO	MONTREAL	OTTAWA	ALL OTHERS
CTOL	27	25	26	20
Rail	16	15	14	12
Bus	21	12	14	12
STOL	14	14/25[1]	26	20

[1] Victoria Carpark/Dorval

Table D5 Average Terminal Times
(minutes)

	Toronto	Montreal	Ottawa	All Other Cities
CTOL				
before departure	39	40	30	20
after arrival	10	10	10	5
Average	25	25	20	12
RAIL				
before departure	27	30	22	15
after arrival	10	10	10	5
Average	19	20	16	10
BUS				
before departure	37	24	22	15
after arrival	5	5	5	5
Average	21	15	13	10
STOL				
before departure	25	25/40[1]	30	20
after arrival	5	5/10	10	5
Average	15	15/25	20	12

[1] Victoria Carpark/Dorval

Estimates were made of STOL average access/egress times and costs by a three step procedure. The first step was to calculate weighted averages of taxi and private auto access/egress costs between each "zone" of each city and the local rail and bus terminals. The second step was to calculate a weighted average of these times and costs, with weights selected to reflect the location of the STOLport site in relation to the rail and bus terminal locations. The third step was to determine suitable weightings for the various zones in each city for the purpose of calculating average access/egress times and costs for STOL passengers in each city. If one were to assume that on each route the STOL passengers diverted from each of the other modes have the same geographical distribution of trip origins and destinations as all passengers using those modes, an underestimate of STOL access/egress time savings would likely result. On the other hand, if STOL access/egress times were calculated on the assumption that those passengers electing STOL over other modes were the ones who would benefit the most in terms of access/egress times, then <u>overestimates</u> of STOL access/egress time savings could be expected. These underestimates and overestimates will henceforth be referred to as <u>minimum</u> and <u>maximum</u> STOL access/egress time estimates.

The Systems Analysis Branch of the CTC calculated, for each of several routes, minimum and maximum STOL access/egress times for passengers diverted from CTOL, rail and bus, for each level of STOL penetration between zero and one hundred percent.[1]

An analysis of this information suggests that for passengers diverted from CTOL, STOL minimum and maximum average access/egress times can be reasonably approximated on a city basis, for Montreal and Toronto, as indicated in Table D6. Further, it was found that the average <u>CTOL</u> access/egress times of CTOL passengers diverted to STOL are not significantly influenced by the degree of STOL penetration into CTOL. It was concluded, therefore, that the average <u>CTOL</u> access/egress times for CTOL passengers diverted to STOL would be the same as for all (short-haul, business) CTOL passengers.

---

1 Observe that the minimum estimate is an increasing function of penetration and equals the maximum estimate when the penetration equals one hundred percent.

Table D6 STOL Average Access/Egress Times, Montreal and Toronto

STOL Penetration Into CTOL	Montreal		Toronto	
CTOL	Minimum	Maximum	Minimum	Maximum
20%	8	17	9	18
30%	8	17	9	18
40%	9	17	10	18
50%	10	17	11	18
100%	17	17	18	18

In contrast to the results obtained for STOL passengers diverted from CTOL, STOL access/egress times for passengers diverted from rail and bus were found to be approximately equal to average rail and bus access/egress times, over the penetration ranges of interest. This was because of the relatively close proximity of STOLports to rail and bus terminals (as compared to the proximity of STOLports to CTOL airports). Consequently, average STOL access/egress times for STOL passengers diverted from rail and bus were assumed to be the same as the average access/egress times for rail and bus passengers, respectively.

On the basis of these results, average access/egress times for all STOL passengers have been estimated to be 14 minutes for both Toronto and Montreal. This figure is based upon an estimated access/egress time for STOL passengers diverted from CTOL of 12-13 minutes (from Table D6), adjusted upward by 1-2 minutes to account for the proportion of STOL passengers who would be diverted from rail and bus.[1] In all other cities, STOL and CTOL access/egress times were assumed to be the same.

Total average access/egress times and costs in going from city A to city B (or from city B to city A) were calculated by simply adding together the average access/egress times and costs for each of the two cities, for each mode.

---

[1] The average access/egress costs adopted are those corresponding to the access/egress times which have been assumed, although the correlations between access/egress costs and minimum access/egress times were found to be very weak for STOL penetrations into CTOL traffic in the range of 20% to 50%.

Terminal Times

Pre-departure terminal time estimates for CTOL, rail and bus business passengers travelling within the Windsor-Quebec corridor were also obtained from responses to the CTC passenger survey described above, for Montreal, Toronto and Ottawa.[1] Average pre-departure terminal times at the Montreal and Toronto STOLports were estimated to be not less than 20 minutes, but not more than 30 minutes, the latter being the average pre-departure terminal time for short-haul business passengers at Ottawa International Airport. An average of 25 minutes has been adopted, which is 15-18 minutes less than average pre-departure terminal times (for short-haul business travellers) at Malton and Dorval.[2] Pre-departure terminal times for smaller CTOL airports were estimated to be 20 minutes.

Average CTOL and rail post-arrival terminal times were estimated to be 10 minutes in Montreal, Toronto and Ottawa, 5 minutes elsewhere. An average post-arrival terminal time of 5 minutes was estimated for the STOLports in Montreal and Toronto, and for bus terminals in all cities.

For cities in which STOL would share CTOL facilities, CTOL pre-departure and post-arrival terminal times have been used, on the assumption that CTOL carriers could achieve the same terminal time saving as STOL for short-haul flights, in which case the difference in terminal times would remain the same.

Blocktimes

Blocktimes for CTOL, rail and bus are taken from published schedules. Blocktimes for auto are estimated on the basis of road distances and average speeds. Blocktimes for STOL were extrapolated from detailed blocktime analyses done by Air Canada for the Montreal-Toronto, Montreal-Ottawa and Toronto-Ottawa routes, which considered prevailing winds, probable area navigation flight profiles, etc.

---

1 These CTOL terminal time estimates may over-estimate average times associated with business passengers using Air Canada's Rapidair service between Montreal and Toronto. Similar streamlining of procedures on other routes could also result in a response to STOL competition.

2 A five minute error in this estimate would influence overall average trip time savings with STOL by slightly less than 3 minutes.

The Air Canada STOL blocktime estimates were based on the assumption that STOL operations at Ottawa would continue to be based at Rockcliffe Airport, in which case there would be no interference between STOL and CTOL flights on approach to landing in Ottawa. However, locating STOL operations at Ottawa International -- as assumed in this study -- would create air traffic control problems which would result in delays to some STOL and/or CTOL flights. The problem would be in merging jet CTOL aircraft with the slower flying DASH-7 on approach to landing. The assignment of a DASH-7 to an arrival position in front of a jet aircraft would necessitate a greater separation between the two aircraft and an earlier reduction in the jet's speed than would be the case if the two aircraft were flying at roughly the same speed. The magnitude of the increased delay for CTOL and/or STOL flights has not been estimated.

The problem just described would exist at all airports used for both CTOL and STOL operations. It would be most acute at Dorval International Airport (for the Single STOLport Option), followed by Ottawa, Quebec City and London. No significant problems are anticipated at Windsor Airport.

The problem could perhaps be overcome by confining STOL operations to existing runways not used by CTOL traffic, or by the construction of additional runways. The feasibility and cost implications of these possibilities have not been examined in detail for those airports which would be concerned.

Thus, the STOL blocktimes adopted may tend to underestimate the actual STOL blocktimes for those STOL flights which terminate at conventional airports, and some CTOL jet flights may experience some landing delays at airports also used for STOL operations.

Frequency of Service

In addition to travel time savings, STOL could -- by virtue of the relatively small fifty-seat capacity of the DASH-7 -- provide frequent service on the busier routes (especially Montreal-Toronto, Montreal-Ottawa and Toronto-Ottawa). As a result there would be an increased number of scheduled flights on each route (STOL plus CTOL), although the frequency of DASH-7 STOL flights alone would probably not exceed that of CTOL flights without STOL (because of connecting CTOL passengers) except perhaps on the shorter routes where most of the STOL traffic would be diverted from the surface modes.

STOL would probably result in some reduction in overall CTOL flight frequency, depending upon the level of STOL penetration and the extent to which air carriers -- notably Air Canada -- would choose to fly smaller aircraft in order to maintain frequency of service. If frequency were reduced, CTOL o/d passengers would clearly experience a reduction in service. The effect on CTOL connecting passengers is less clear. Although there would be fewer flights to choose from to "optimize connections", it has also been suggested that a reduction in o/d passengers would permit more efficient scheduling for connecting flights.

2. AVERAGE ACCESS/EGRESS COSTS

Estimates of access/egress cost savings realized by STOL users have been developed in this Appendix, not because such cost savings should be regarded in themselves as benefits of STOL, but simply because it is convenient to do so at this time, in parallel with the development of access/egress time savings. As access/egress time savings represent just one component of total trip times, so do access/egress cost savings represent only one component of total trip cost. Hence, the discussion of their significance, in the context of total trip costs, appears in Appendix C.

The procedure for calculating average access/egress costs per passenger for CTOL, rail, bus and STOL has been described in the previous section. Access/egress costs for auto are assumed to be zero. Access/egress cost estimates for other modes are contained in Table D7 by city, and in Table D8, by route, and over all routes, for each of the two STOL system options.[1] Thus, one may conclude that STOL would result in an average reduction in access/egress costs of approximately \$2.30 per passenger for the Two STOLport Option and \$1.68 per passenger for the Single STOLport Option. The average access/egress cost savings for the STOL passenger diverted from CTOL can be shown to be \$3.75 per passenger for the Two STOLport Option and \$2.35 per passenger for the Single STOLport Option.

---

1 Note that use of a "STOLmobile" by the STOL carrier has not been explicitly assumed. Although the integrated access/egress-intercity service provided by Airtransit was extremely popular and highly efficient, there may be problems in extending such a service to a much larger operation with the 50-seat DASH-7 (e.g., problems of logistics with the larger aircraft and multiple pick-up points).

Table D7 Average Access/Egress Costs by City
($1976)

Mode	Toronto	Montreal	Ottawa	All Other Cities
CTOL	3.88	3.83	3.35	2.40
RAIL	1.99	1.22	1.22	.90
BUS	1.14	.99	.94	.90
STOL	1.53	1.45/3.83*	3.35	2.40

*Victoria Carpark/Dorval

Table D8, Average Access/Egress Costs by Route
($1976)

ROUTES	CTOL	RAIL	BUS	AUTO	w/o STOL[1]	STOL	STOL Savings
Montreal-Toronto	7.71	3.21	2.13	0	7.09/7.33	2.98/5.36[2]	4.11/1.97[2]
Montreal-Ottawa	7.18	2.44	1.93	0	3.22	4.80	-1.58
Montreal-Quebec	6.23	2.12	1.89	0	3.72	3.85	- .13
Toronto-Ottawa	7.23	3.21	2.08	0	6.93	4.88	2.05
Toronto-London	6.28	2.89	2.04	0	3.21	3.93	.72
Toronto-Windsor	6.28	2.89	2.04	0	4.71	3.93	.78
Toronto-Sudbury	6.28	2.89	2.04	0	5.72	3.93	1.79
Route Weighted Average[3]							
Two STOLport Option					6.00	3.71	2.29
Single STOLport Option					6.61	4.93	1.68

[1] Using weights contained in Table D1.
[2] Victoria Carpark/Dorval.
[3] Using weights contained in Table D2.

3. IMPACT ON CTOL AIRPORT FACILITIES

It has often been argued that one important benefit of STOL is the potential relief that it might provide to strained CTOL airport facilities in general, and to Malton Airport in particular. That is, if STOL were to divert passengers from CTOL flights there would naturally follow a reduction in demand for CTOL airport runways, gates, terminals, parking, etc. It is the purpose of this section to examine the implications for the three airports which might be affected by the establishment of an intercity STOL system: Malton, Pickering (proposed), Dorval and Mirabel.

Malton Airport

Because of the suspension of plans for the new Pickering Airport, it will be necessary for Malton to continue to serve as the only major airport facility in the Toronto area through the early to mid-1980s. In view of projected increases in traffic and apparent restraints on the expansion of Malton, it can be expected that airport capacity will be reached by the latter part of this decade and that congestion and delays will become progressively worse thereafter.

The introduction of STOL at Toronto Island could provide some relief to Malton until additional capacity is made available in the Toronto area. STOL could also result in modest reductions in noise levels in the vicinity of Malton, unless the diversion of short-haul domestic flights to Toronto Island were to result in the transfer of additional long-haul domestic, transborder and/or international flights to Malton.

There are two principal capacity problems at Malton - gate/terminal capacity and runway capacity. These two problems will be discussed in turn.

The problem of gate/terminal capacity will first be felt in Terminal 1, which now serves most carriers other than Air Canada. The problems will be most acute for (and are principally caused by) transborder and international flights, which place the heaviest burdens on virtually all airport facilities (e.g., gates, holding areas, customs and immigration, baggage carousels, greeters and well-wishers areas, etc.). By contrast, it is expected that gates and baggage carousels for domestic flights at Terminal 2 will be adequate to meet Air Canada's requirements at least through the early 1980s.

A diversion to STOL of up to 40% of Air Canada's domestic short-haul traffic (at Malton), would reduce the number of passengers using the domestic portion of Terminal 2 by up to 20%, which would possibly allow for the transfer of some domestic traffic from Terminal 1 to Terminal 2. Even if this were possible, however, it would provide little relief in Terminal 1, both because gate occupancy times for domestic short-haul flights are considerably shorter than for other types of flights, and because many of the gates in both terminals are not interchangeable between different types of aircraft. Moreover, a transfer of domestic traffic would provide no relief for customs and immigration operations and little for greeters and well-wishers areas.

Thus, a diversion of short-haul domestic traffic to STOL would provide little relief to the problems of terminal and gate congestion at Malton Airport in the early 1980s. Moreover, it is the general opinion of airport planning experts within Transport Canada that the benefit to gate and terminal congestion problems would be less significant than the benefit to the runway capacity problem, which will now be addressed.

There are four runways at Malton; two parallel East-West runways, one North-South runway and one runway used principally for general aviation. The two East-West runways have a combined capacity of approximately 69 movements per hour; the North-South runway has a capacity of approximately 39 movements per hour. Between 90% and 95% of the time weather conditions permit the use of two of the three runways for commercial operations, and under these conditions there is sufficient capacity to accommodate traffic growth through the mid-to-late 1980's. The capacity problem exists during the 5%-10% of the time when only the North-South runway can be used.[1] It is expected that by 1982 there will be a requirement for 48 scheduled aircraft movements per peak-hour, which significantly exceeds the capacity of the North-South runway. During such periods (which are sometimes short in duration and other times prolonged), queues of aircraft will develop on the ground and in the air, resulting in additional operating expenses for the carriers and delays for the passengers.

---

1 Recently, runway operations have been confined to the North-South runway approximately 19% of the time (due to strong crosswind conditions, marginal crosswind conditions, and for reasons of noise abatement). It has been estimated, however, that this figure could be reduced to perhaps 5%, as peak-period demand for runways increases. Because of the uncertainty over this figure, a range of 5% - 10% has been used in this study.

There are two principal peak periods at Malton, one between 3:00 p.m. and 4:00 p.m. (mostly arrivals) and the other between 6.00 p.m. and 7:00 p.m. (mostly departures). Between 3:00 p.m. and 7:00 p.m. STOL would divert passengers mainly from the 4:00 p.m. to 6:00 p.m. period, which is on the shoulders of both CTOL peaks. A simplified analysis now follows for the purpose of estimating the average reduction in waiting time per flight (arrivals and departures) which might result from a diversion of CTOL traffic to STOL. The analysis pertains only to the situation where the North-South runway is the only one in operation.

Define:

h = the number of hours elapsed after practical runway capacity (39 movements/hr.) is reached.

s = the number of scheduled flights per peak-hour without STOL.

$f(h,s)$ = the number of scheduled flights waiting for take-off or landing after h hours.

$= h(s-39)$

$w(h,s)$ = average delay per aircraft, after exceeding runway capacity for h hours.

$= 1/2\ (1/39) f(h,s) \qquad = 1/2\ (1/39) h(s-39)$

$= .0128h(s-39)$

Thus, if STOL were to reduce the number of scheduled flights per hour by s^0 the reduction in the average delay per aircraft (call it $r(h-s^0)$) would be

$r(h,s^0) = w(h,s) - w(h,s-s^0)$

$= .0128h(s-39) - .0128h(s-s^0-39)$

$= .0128hs^0$

It is expected that in 1980 STOL would divert between 200 and 385 CTOL passengers per hour from Malton between 3:00 p.m. and 7:00 p.m. during peak periods; by 1985 between 275 and 500 CTOL passengers would be diverted per peak-hour. Assuming an average number of seats per short-haul aircraft of 150[1], and an average peak-hour load factor of 80%, one may assume that as a result of STOL, aircraft movements at Malton may decrease by an average of between 1.7 and 3.2 per peak-hour in 1980, increasing to between 2.3 and 4.2 by 1985.[2]

---

[1] Equals the average number of seats on all Air Canada scheduled flights between Toronto and Montreal during typical week in 1976 (excluding Boeing 747s).

[2] This assumes that CTOL flights would reduce in proportion to reductions in traffic volumes. If, however, to maintain frequency Air Canada were to switch to smaller CTOL aircraft on certain routes, the above estimate would be too large.

Thus, during the early 1980s STOL might result in an average decrease in CTOL flights between 3:00 p.m. and 7:00 p.m. of perhaps 1.9 to 3.6 per hour (1982 level). Hence, the average delay experienced by all passengers arriving or departing between 3:00 p.m. and 7:00 p.m. during periods where only the North-South runway is in use, would be between r(h,1.9) and r(h,3.6) hours during the early 1980s. If h, the duration of the single runway operation, were between 1 and 3 hours, the average reduction in delay would be between r(1, 1.9) = (.0128)(1)(1.9) = .024 hours and r(3,3.6) = (.0128)(3)(3.6) = .138 hours; that is, between 1 and 8 minutes.[1]

It is expected that without STOL there will be in 1982 an average of approximately 48 scheduled flights (arrivals plus departures) per hour during the four-hour period between 3:00 p.m. and 7:00 p.m. at Malton. Assuming that STOL would be in full operation for 250 days per year, and that operations would be confined to the single North-South runway approximately 5% of the time, it follows that during 1982 roughly (.05)(250)(4)(48) = 2400 flights would benefit by a reduction in delay of between 1 and 8 minutes each.[2] If operations were confined to the North-South runway 10% of the time, approximately twice that number of flights would be affected. Assuming that each such flight were to carry an average of 160 passengers, a total of between perhaps 380,000 and 760,000 passengers would therefore each benefit from the same reduction in delay.[3]

---

1 Under the above assumptions, the maximum reduction in average delay during the period between 3 p.m. and 7 p.m. would be about r(4,3.6) = .184 hours, or about 11 minutes.

2 Again, assuming that CTOL carriers would not, as a response to STOL, switch to smaller aircraft.

3 Because the trip time calculations in Section 1 of this Appendix did not take into consideration the runway delays considered here (i.e., the CTOL trip time for flights originating or terminating at Malton during peak-hour periods when only the North-South runway is in use), some adjustment in time savings is perhaps warranted. However, the adjustment is insignificant -- fewer than 3% of all STOL travellers would have total trip times savings underestimated by between 1 and 8 minutes.

Assuming that marginal costs for CTOL aircraft operations were approximately $800 per hour, annual operating cost savings would amount to something between $30,000 and $500,000 in 1982.

To put these time and cost savings in perspective, it is expected that STOL would attract between 0.8 and 1.8 million passengers in 1982 (depending upon which option and STOL passenger level is assumed). The total time savings realized by CTOL passengers would therefore equal an equivalent total time savings of between 1 and 4 minutes for each STOL passenger. Similarly, the savings in carrier costs would represent between 4¢ and 27¢ per STOL passenger.

In addition to reducing passenger delays at Malton, the diversion of CTOL traffic to STOL would also help to reduce delays at other airports resulting from the delays at Malton. Moreover, the reduction in delays due to STOL, and the number of CTOL passengers affected would increase between 1982 and 1985. However, it would appear that the overall benefits to CTOL passengers and carriers, in terms of reduced delays, would be quite small in relation to the other costs and benefits associated with STOL.

A reduction in CTOL short-haul flights might also reduce noise levels slightly around Malton. For example, in 1982 a reduction of 1.9 to 3.6 DC-9 and 727 movements per hour during the late afternoon and early evening periods would result in an overall decrease in aircraft movements of between 4% and 8% during this four-hour period. The reduction in noise exposure (NEF) is much smaller on a percentage basis because of the logarithmic nature of the calculation and also because STOL would have no effect on the number of late evening and long-haul flights, which both have a much greater influence on perceived noise levels. Aircraft noise experts in Transport Canada are of the opinion that the diversion of flights from Malton would have little overall effect on noise levels, to the extent that the reduction in airport noise would probably not be noticed by most residents in the immediate airport area.[1]

---

[1] As was noted previously, the reduction in noise at Malton resulting from the transfer of some domestic short-haul traffic could be offset by higher noise levels associated with a corresponding increase in transborder and long-haul domestic and international traffic.

In summary, a diversion of some domestic short-haul traffic from Malton would benefit most the problem of insufficient runway capacity, but that benefit would be relatively small in comparison with other costs and benefits associated with STOL. The reduction in CTOL flights at Malton would also provide a small measure of relief for gate and terminal facilities, and would slightly reduce noise levels in the vicinity of Malton.

Proposed Pickering Airport

At the present time, it is not known when, if ever, the proposed Pickering Airport will be built. If a decision were taken to build a major new airport in the Toronto Area at Pickering, or elsewhere, the introduction of a STOL system could slightly delay the need for the new airport. To the extent that capital expenditures would be delayed, as a result of STOL, the associated <u>reduction in the present value</u> of those capital expenditures would be a "STOL" benefit.

Other Transport Canada studies have estimated the total capital cost of Phase 1 of the proposed Pickering Airport, including the associated provincial roads and services, at approximately \$800M (in 1976 dollars). Further, it is estimated that the airport would take approximately seven and one-half years to design, plan and construct, and that the present value of all capital costs would be approximately the same as total capital costs (\$800M) discounted <u>six</u> years.

Thus, if STOL were to delay the need for a major new airport in the Toronto area for "n" years, the economic benefit (in millions of \$1976) would be:

Equation (1) $\quad (1+r)^{-6}(800) - {}^{-6-n}(800)$

where r is the social discount rate (e.g., r = .10).

It is extremely difficult to estimate the extent to which the introduction of STOL would delay the need for a major new airport in the Toronto area. As noted previously, while terminal and (aircraft) gate congestion at Malton will be much more severe in Terminal 1 than in Terminal 2, the diversion of short-haul CTOL traffic to STOL would only directly benefit Terminal 2. It may be possible to transfer some traffic from Terminal 1 to Terminal 2 (with or without the introduction of STOL), as a means of "balancing" the congestion between the two terminals, but this would involve substantial terminal renovation costs, and could create serious operating problems for the air carriers affected.

The following procedure was used for estimating the delay in the need for major new airport facilities in the Toronto area, as a result of STOL:

Step 1 - Estimate annual growth in peak-hour enplanements and terminal occupancy at Malton (for Terminals 1 and 2 combined), immediately <u>prior</u> to the earliest opening date of a new airport in the Toronto area, assuming a STOL system were <u>not</u> established.

Step 2 - Estimate the diversion of traffic from Malton to a Toronto Island STOLport, in terms of the equivalent numbers of years growth in peak-hour enplanements and peak hour terminal occupancy at Malton (assuming a STOL system is <u>not</u> established), for both STOL system options, and for "high" and "low" STOL traffic volumes. The results are shown in Table D9.

Step 3 - Estimate the delay in the need for a major new airport in the Toronto area, as a result of STOL. Initially, it was estimated that if forecasted traffic at Malton were perfectly "balanced" between sectors and terminal buildings, and if, with the diversion of short-haul CTOL traffic to STOL all sectors and both terminal buildings could be "re-balanced" perfectly, at no cost, the delay in the need for a new airport would be a weighted average of the peak-hour enplanement and terminal occupancy growth figures in Table D9. Weights of 1/3 and 2/3 were adopted for the respective measures. The <u>actual</u> delay in the need for a new airport, as a result of STOL, was estimated to be 1/2 of this "theoretical maximum" delay estimate, in view of the nature of the terminal congestion problem at Malton, and the potential for utilizing the "space" freed up by the diversion of the short-haul traffic from Terminal 2. These estimates, and the associated economic benefits, calculated from the equation on the preceding page, are contained in Tables D10 and D11.

Table D9 - Estimated Diversion of CTOL Traffic TO STOL, in Terms of Equivalent Numbers of Years Growth in Peak Hour Enplanements and Terminal Occupancy at Malton, Without STOL
(in years)

	Enplanements	Terminal Occupancy
Two STOLport Option		
high volume	1.04	.43
low volume	.63	.26
Single STOLport Option		
high volume	.91	.37
low volume	.57	.23

Table D10 - Estimate of Delay in Need for Major New Airport in Toronto Area as a Result of STOL
(in years)

Two STOLport Option		
high STOL volume	.31	(3.7 mos.)
low STOL volume	.19	(2.3 mos.)
Single STOLport Option		
high STOL volume	.27	(3.2 mos.)
low STOL volume	.17	(2.0 mos.)

Table D11 _ Estimated Economic Benefit Associated with Delay in Need for Major New Airport in Toronto Area, as a Result of STOL
(present value, millions of $1976)

	Social Discount Rates		
	5%	10%	15%
Two STOLport Option			
high STOL volume	9.0	13.2	14.6
low STOL volume	5.5	8.1	9.0
Single STOLport Option			
high STOL volume	7.8	11.5	12.8
low STOL volume	4.9	7.3	8.1

Dorval and Mirabel Airports

With the transfer of approximately three million international passengers per year to Mirabel in 1975, Dorval is well below effective airport capacity and is not expected to reach the 1975 level of nine million passengers again before the mid-1980s. However, noise levels at Dorval are expected to be as high in the early 1980s as they were in 1974. Thus, noise considerations may dictate some additional transfer of traffic to Mirabel before the mid-1980s.

Any additional significant transfer of operations from Dorval would first require the construction of additional terminal capacity at Mirabel. Hence, to the extent that STOL would divert passengers from CTOL and thereby reduce the volume of domestic short-haul flights at Dorval, some delay in the construction of additional capacity at Mirabel might be possible.[1] Further, a delay in transferring passengers to Mirabel would result in access/egress time and cost savings to those CTOL passengers affected.

The extent of these benefits would depend on whether Montreal STOL operations would be based at Victoria Carpark or at Dorval Airport. In the latter case, the benefits would be extremely small, both because of the smaller passenger volumes involved (with Toronto Island-Dorval being the only route) and because of the increased demands that the relatively small DASH-7 would place on gate, terminal and runway facilities at Dorval. Some reduction in airport noise levels would result but it would be very slight.

If Montreal STOL operations were based at Victoria Carpark an average of between 190 and 325 passengers per peak-hour would be diverted from Dorval in 1980; by 1985, between 250 and 425 passengers per peak hour would be diverted. Assuming an average short-haul aircraft capacity of 150 seats, and an 80% peak-hour average load factor, this would result in a reduction of between 1.6 and 2.7 domestic short-haul flights per peak-hour in 1980, increasing to between 2.1 and 3.6 flights per hour in 1985. Overall, this might result in a reduction in peak-hour CTOL flights of between 7% and 13%.

---

[1] Provided Montreal STOL operations were not based at Dorval.

Because the noise exposure level varies with the logarithm of the number of flights, a reduction in short-haul CTOL flights would result in a proportionately smaller reduction in overall noise levels. Further, STOL would not significantly reduce the number of late evening flights, which is when the noise problem would be most acute. Thus, STOL's contribution to reduced noise in the vicinity of Dorval would probably not result in any appreciable delay in the construction of new terminal facilities at Mirabel to accommodate a portion of the traffic at Dorval.

If, however, airport capacity were to become the limiting factor at Dorval (which is not expected to occur before 1985), a diversion of short-haul domestic traffic to a downtown Montreal STOLport could delay the need for new terminal facilities at Mirabel by perhaps one to three years.[1] Moreover, a delay in transferring flights to Mirabel would result in access/egress time and cost savings for some passengers who would otherwise be required to use Mirabel.

In summary, STOL would probably not significantly delay the need for new terminal facilities at Mirabel if the need were to stem from the problem of airport noise at Dorval. On the other hand, if the need for new facilities at Mirabel were more directly related to terminal congestion at Dorval, then STOL would delay the need for such facilities by perhaps one to three years (provided the Montreal STOL operations were at Victoria Carpark). However, as Dorval is not expected to reach capacity before 1985, the benefit of a delay in construction at Mirabel would be quite small in present value terms. Such a delay would also result in access/egress time and cost savings for passengers who would otherwise be required to use Mirabel (probably long-haul domestic and/or long-haul transborder passengers).

---

[1] Passenger volume at Dorval is expected to grow by about 300,000 per year. As STOL would likely reduce passenger volumes at Dorval by between 0.9 and 1.5 million passengers in 1985, and recognizing that domestic short-haul flights make the least demands on airport facilities, an estimate of one to three years of additional capacity is perhaps not unreasonable.

4. ENERGY IMPLICATIONS

On a per passenger basis, the DASH-7 is a more economic user of fuel than either CTOL short-haul jets or automobiles, and for this reason the development of a STOL system would likely reduce energy requirements for intercity transportation on most of the routes examined in this study. Marginal fuel requirements for each of the modes under consideration are given in Table D12.

Table D12 - Marginal Fuel Requirements Per Passenger by Intercity Transport Mode

(Imp. gallons/passenger)

Mode	Per departure	Per Mile[1]
STOL[2]	2.95	.020
CTOL[2,3]	3.79	.025
Rail[4]	0	0
Bus[5]	0	.009
Auto[6]	0	.031

---

[1] Air or ground statute miles, as applicable.

[2] Assumed 60% load factor.

[3] Assumed DC-9-30 all economy, 103 seats.

[4] Marginal fuel reductions for rail are assumed to equal zero.

[5] Assumed 46 seats and 60% load factor.

[6] Assumed 1.3 passenger per trip and 25 miles/gal. fuel economy during 1980-1990 period.

In addition to fuel savings between cities, STOL would also result in fuel savings over CTOL for access/egress to and from terminals. These savings, which are summarized in Table D13, are assumed to be in direct proportion to required access/egress times. The estimate of energy requirements assumes that all access/egress is by automobile, under the assumptions indicated in Table D14.[1]

On the basis of these assumptions, total fuel consumption per one-way trip is summarized, by route, in Table D15, and over all routes, for each of the two STOL system options in Table D16.

Table D16 shows that STOL would result in an average reduction in fuel consumption per (one-way) trip of approximately one and one-half imperial gallons per passenger, which represents an 11%-14% fuel saving. This would amount to a total average annual fuel saving of between one and two million gallons.

This analysis also provides an indication of the sensitivity of transportation costs to the price of fuel. For example, if the estimates used for the prices of airplane fuel and gasoline during the period 1980-1990 are low by 30¢ per gallon, total economic costs would be overestimated by approximately 30¢ -44¢ per passenger.

To examine the overall impact of STOL on energy consumption it is necessary to look beyond the direct savings. For example, the energy intensive excavation and fill operation likely required for the construction of the Montreal STOLport could in itself result in the consumption of nearly a million gallons of fuel.[2] Needless to say, it is extremely difficult to identify and quantify all of the other indirect energy-related implications of STOL, although one deserves special mention, and that is related to the alternative uses of Toronto Island.

---

1 More precisely, this is the average marginal fuel consumption per passenger, per one-way trip.

2 For example, 110,000 truck trips at 4 miles/gal. and 30 miles per round trip would consume 800,000 gallons of fuel.

Table D13 - Access/Egress Fuel Requirements, by Intercity Transport Mode

(Imp. gals. per passenger)

Mode	Montreal Avg. A/E Time (min.)	Montreal Fuel/ Pass.	Toronto Avg. A/E Time (min.)	Toronto Fuel/ Pass.	Ottawa Avg. A/E Time (min.)	Ottawa Fuel/ Pass.	All Other Cities Avg. A/E Time (min.)	All Other Cities Fuel/ Pass.
STOL	14/25[1]	.21/.50[1]	14	.21	26	.52	20	.40
CTOL	25	.50	27	.54	26	.52	20	.40
Rail	15	.14	16	.14	14	.13	12	.11
Bus	12	.11	21	.19	14	.13	12	.11
Auto	0	0	0	0	0	0	0	0

[1] Victoria Carpark/Dorval

Table D14 - Assumptions Used in Calculating Access/Egress Fuel Requirements

Inter-City Mode	Location	Avg. Inter-City Pass./ Vehicle[1]	Avg. Fuel Consump. rate (miles/ gal.)	Avg. Auto Speed (miles per hour)	Avg. Fuel Consump. per pass.-min (Imp.gal.)[1]
STOL	downtown	1.5	22	30	.015
STOL	CTOL airport	1.5	22	40	.020
CTOL	CTOL airport	1.5	22	40	.020
Rail	downtown	2.5	22	30	.009
Bus	downtown	2.5	22	30	.009

[1] Consumption per passenger-minute = (speed)/[(#pass.) (60) (Fuel consumption rate)]

Table D15. Total (one-way) Trip Fuel Consumption by Route and Mode
(Imp. gals. per passenger)

Montreal-Toronto

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	89	315	1.04	11.66	12.70
Rail	7	350	0.28	0	0.28
Bus	0	350	0.30	3.15	3.45
Auto	4	350	0	10.85	10.85
Av w/o STOL			0.95	10.81	11.76
STOL		315	0.42	9.25	9.67

Montreal-Ottawa

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	35	102	1.02	6.34	7.36
Rail	10	120	0.27	0	0.27
Bus	24	120	0.24	1.08	1.32
Auto	31	120	0	3.75	3.75
Av w/o STOL			0.44	3.64	4.08
STOL		102	0.73	4.99	5.72

Montreal-Quebec City

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	49	146	0.90	7.44	8.34
Rail	18	163	0.25	0	0.25
Bus	15	163	0.22	1.47	1.69
Auto	18	163	0	5.05	5.05
Ave w/o STOL			0.52	4.78	5.30
STOL		146	0.61	5.87	6.48

Toronto-Ottawa

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	95	226	1.06	9.44	10.50
Rail	2	250	0.27	0	0.27
Bus	0	250	0.32	2.25	2.57
Auto	3	250	0	7.75	7.75
Av w/o STOL			1.01	9.20	10.21
STOL		226	0.73	7.47	8.20

Toronto-London

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	29	88	0.94	5.99	6.93
Rail	38	120	0.25	0	0.25
Bus	14	120	0.30	1.08	1.38
Auto	19	120	0	3.72	3.72
Av w/o STOL			0.41	2.60	3.01
STOL		88	0.61	4.71	5.32

Toronto-Sudbury

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	87	211	0.94	9.07	10.01
Rail	8	251	0.25	0	0.25
Bus	1	251	0.30	2.26	2.56
Auto	4	251	0	7.78	7.78
Av w/o STOL			0.84	8.22	9.06
STOL		211	0.61	7.17	7.78

Toronto-Windsor

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	59	194	0.94	8.64	9.58
Rail	34	235	0.25	0	0.25
Bus	1	235	0.30	2.12	2.42
Auto	6	235	0	7.29	7.29
Av w/o STOL			0.64	5.56	6.20
STOL		194	0.61	6.83	7.44

Dorval-Toronto

Mode	% of STOL traffic	Stagelength (miles)	Fuel Consumption Per Passenger		
			Access/ Egress	Inter-City	Trip Total
CTOL	93	315	1.04	11.66	12.70
Rail	5	350	0.28	0	0.28
Bus	0	350	0.30	3.15	3.45
Auto	2	350	0	10.85	10.85
Av w/o STOL			0.98	11.06	12.04
STOL		315	0.71	9.25	9.96

If Toronto Island were used for recreational purposes one would not expect the implications for energy consumption to be significant. However, if the property were used for housing, and if as a consequence the stock of downtown housing were increased, which in turn resulted in an overall reduction in average commuting distances, the potential energy savings associated with that land use could approach the transportation-related energy savings associated with STOL.

It is not the intent of this example to doggedly pursue every BTU which STOL might expend or conserve, or prevent from being conserved, but to illustrate the intrinsic difficulty of identifying the energy implications in their totality, and of describing those implications in such a way that they can be assessed in the context of the basic issue under investigation.

Table D16 - Total Energy Consumption Per Passenger, All Routes
(Imp. gals. per passenger)

	%STOL passengers		Access/Egress		Inter-City		Trip Total		
	Two STOL-ports	Single STOLport	STOL	w/o STOL	STOL	w/o STOL	STOL	w/o STOL	STOL Savings
Montreal-Toronto	50	0	.42	.95	9.25	10.81	9.67	11.76	2.09
Dorval-Toronto	0	55	.71	.98	9.25	11.06	9.96	12.04	2.08
Montreal-Ottawa	12	0	.73	.44	4.99	3.64	5.72	4.08	-1.64
Montreal-Quebec	6	0	.61	.52	5.87	4.78	6.48	5.30	-1.18
Toronto-Ottawa	16	22	.73	1.01	7.47	9.20	8.20	10.21	2.01
Toronto-London	5	8	.61	.41	4.71	2.60	5.32	3.01	-2.31
Toronto-Windsor	5	6	.61	.64	6.83	5.56	7.44	6.20	-1.24
Toronto-Sudbury	6	9	.61	.84	7.17	8.22	7.78	9.06	1.28
Route Weighted Average									
Two STOLport Option			.55	.82	7.78	8.50	8.33	9.32	.99
Single STOLport Option			.69	.91	8.16	9.39	8.85	10.30	1.45